THE CORNELL ENGINEER

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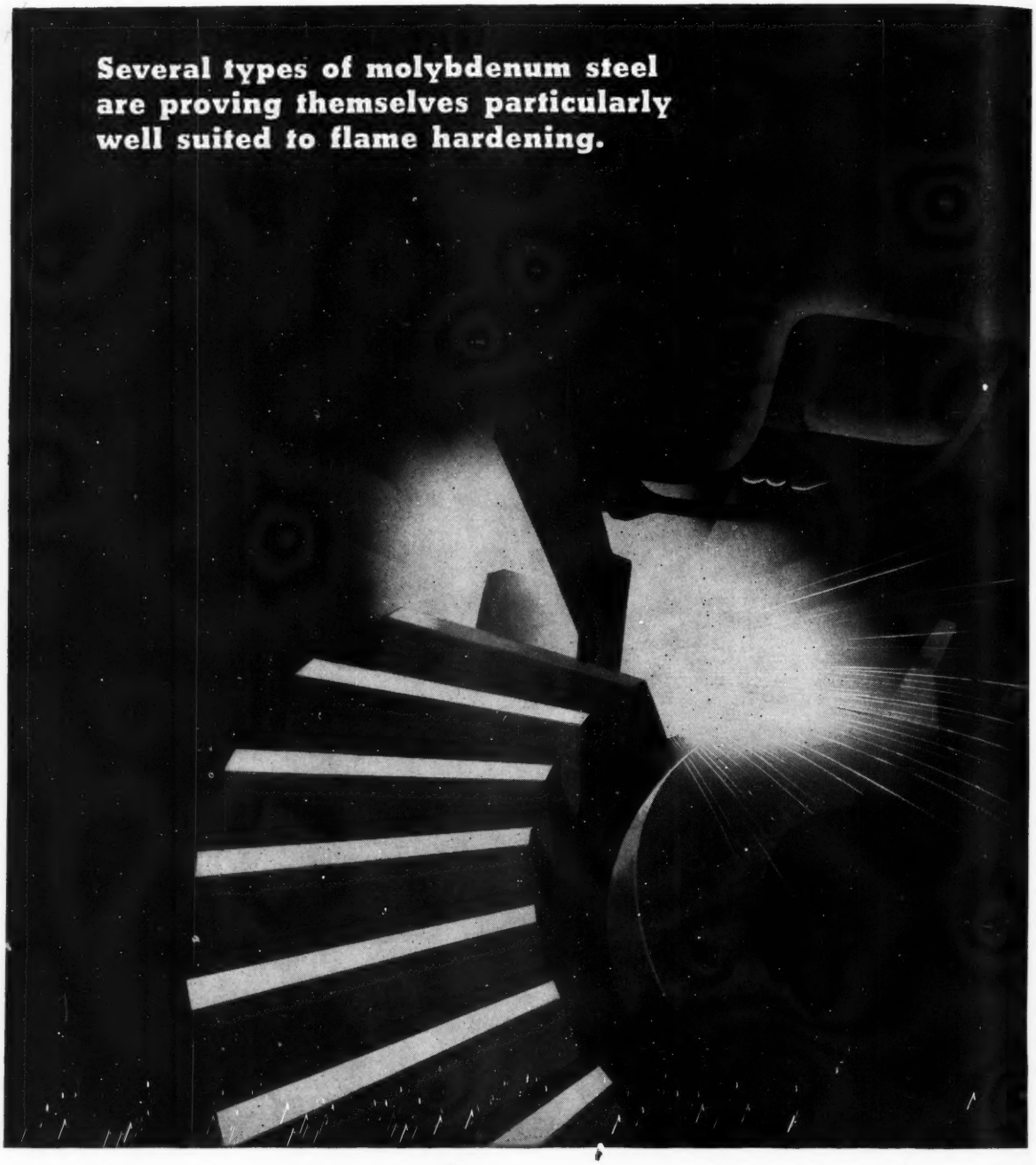
Several types of molybdenum steel are proving themselves particularly well suited to flame hardening.



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The CORNELL ENGINEER

1945

Volume 10 Number 8

CONTENTS

THE FACULTY SAYS 7

AN ENGINEER IN RUSSIA 8
Prof. George Winter, Ph.D. '40

ALUMINUM—STRUCTURAL METAL OF THE FUTURE 10
Herbert S. Meltzer, CE '47

POWDER METALLURGY 12
Donald S. Ironside, EE '46

SOME USEFUL LABORATORY GADGETS 14
Robert H. Olson, ChE '46

ENGINEERING AT CORNELL—7 16
Anthony S. Rugare, ME '47

PROMINENT ENGINEERS 18

NEWS OF THE COLLEGE 20

ALUMNI NEWS 21

CAUSTIC 22

PROFILES 23

TECHNI BRIEFS 24

PRESIDENT'S MESSAGE 26

TEACHERS 27

STRESS AND STRAIN 54

INDEX, VOLUME 10 56

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COVER

Dneiper-Petrovsk Dam, near Stalingrad was built by American engineers.

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FRONTIS

The 100-foot General Electric two-bay circular antenna which the Columbia Broadcasting System recently erected atop a use by WABC-FM to serve the New York City building for Big City's millions.

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This issue: May, 1945.

Replies

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Vol. 10

THE CORNELL ENGINEER

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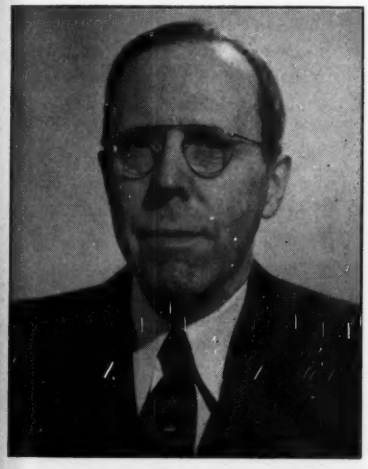
Replies to "Professors on Pro"

THE FACULTY SAYS . . . .

Prof. F. O. Ellenwood

IN response to the editor's invitation for brief comments on the editorial "Professors on Pro?" in



Prof. Ellenwood

the February issue of THE CORNELL ENGINEER, allow me to express my approval of this excellent editorial. I believe the subject is well worth the careful consideration of all teachers in a large university regardless of rank or field of work.

The engineering faculty at Cornell is made up of various types of men most of whom are, according to the editorial, doing their work well. We are all human, however, and may therefore be expected to have our individual shortcomings that may possibly create worse impressions than we realize. Is it not fitting, therefore, that our students should be given the opportunity to express their opinions, as to the quality of work we are doing? Any

(Continued on page 48)

Prof. F. H. Rhodes

IT cannot be denied that in the College of Engineering, as in other colleges at this and other universities, there are instances of poor teaching. To estimate the number of these cases is rather difficult; one poor teacher on a faculty, like one rock in a camp bed, can cause considerable comment. Infrequency of occurrence is, however, no justification for refusal to consider the problem seriously. Every student has the right to proper and adequate instruction in every course for which he is registered.

The editorial implies that the principal cause of ineffective teaching—if not the only one—is lack of interest on the part of the instructor. This, I think, is not true. Many instructors are ineffective largely because they do not realize their own lack of effectiveness; they have not learned to put themselves in the place of the student and to visualize the difficulties that he encounters in absorbing the content of the course. A very common cause of poor instruction is lack of attention to the mere mechanics of teaching. We all know the dear old professor who turns his back on the class and continues his monologue while writing on that particular spot of the blackboard that is most completely hidden from the audience. These few examples sup-

(Continued on page 32)

Prof. Rhodes

AN ENGINEER IN RUSSIA

By PROFESSOR GEORGE WINTER, Ph.D. '40

NINETEEN-THIRTY was not a good year for graduation. The depression was at its height and, as usual, it hit the construction industry more than any other. As a consequence, after the firm I was working for had folded up, I found myself early in 1932 with the position of a division engineer on the construction of a big meat packing plant of the Chicago pattern in Sverdlovsk, capital of the Ural district, U.S.S.R. I stayed in this city in various capacities for six years.

Engineering experience in Russia certainly was "different." An exceedingly limited stock of Russian engineers, mostly young and inexperienced (and in that not much different from the writer); a lack of mechanized construction equipment; a very severe climate; a critical lack of steel reminiscent in a way of our own situation for the past few years, only worse; peculiar problems involved in a planned state economy; an unskilled labor supply, consisting mainly of farmhands—all these things posed problems which could not be solved with a slide rule or handbook.

First Problem

The first problem I had to face was characteristic of the entire situation. The plans for the meat packing plant had been made by one of the American firms who specialized in that field. Data on soil conditions had been given to that firm on the basis of about a dozen open test pits which were supposed to reveal the soil properties on a building site about two miles square! No tests had been conducted and no borings made below the level of the footings. I arrived on the site during the thaw period and had an excellent opportunity to observe how the soil behaved. By mere inspection I was convinced that the perfunctory survey on which the design of these capital structures was based was not only insufficient but definitely unsafe. To arrive at this conclusion was one thing, to do something about it quite another. With not more background than a rather solid course in soil mechanics and some personal experience with soils which did not bear the remotest resemblance to those on the site, I set out to convince the chief engineer, the director of the construction (a party man with chiefly managerial and political functions), the chief engineer of the Moscow home office and its director, and through them, the proper authorities in the people's commissariat of food industries, that a thorough soil investigation and probable re-design of the foundations had to be undertaken. The length of time it took to push this matter through was commensurate with the length of the list above.

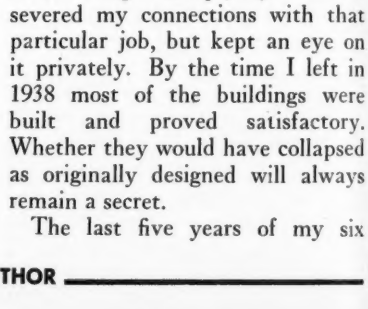
New Investigation

The measure having been approved, I undertook the soil investigation exclusively with such makeshift equipment as I could devise by myself on the site: boring instruments, test load arrangements and the rudiments of such other testing equipment as was the minimum necessary to arrive at valid conclusions. On the basis of all this it was found, as anticipated, that many of the foundations as originally designed were unsafe and had to be changed completely. Later I severed my connections with that particular job, but kept an eye on it privately. By the time I left in 1938 most of the buildings were built and proved satisfactory. Whether they would have collapsed as originally designed will always remain a secret.

The last five years of my six

THE AUTHOR

A native of Vienna, Austria, Professor George Winter received his C.E. degree from Munich Institute of Technology in 1930. After two years of design and construction work in Vienna he went to Russia where he stayed from 1932 to 1938. Stationed in Sverdlovsc, capital of the Ural District, he was in charge of the structural design of large industrial plants and also served as lecturer at the Mining Institute. He came to Cornell in 1938, received his Ph.D. in 1940 and was appointed assistant professor of Civil Engineering in 1942. He is at present conducting extensive research work for the American Iron and Steel Institute and has published many research papers in the structural field.



Prof. Winter

(Courtesy Portland Cement Assn.)

A scene showing the application of precast reinforced concrete in the United States.

years stay I spent on the structural design of plants for heavy industry, such as metallurgy, power plants, mining and the like. When the Russians started their great industrialization program in 1928, they had no experience whatever with designing of such plants, all of their older industrial establishments having been constructed by foreign firms. In this predicament they engaged the help of foreign design firms, not so much to have the plants designed abroad as to learn the know-how from them. One of the outstanding organizations of this kind was Albert Kahn, Architects and Designers, a Detroit firm which, among other projects, had designed many of the large automobile factories in this country. During the following years, several scores of Albert Kahn men organized a large design office in Moscow with several branch offices, and with a mixed American-Russian staff. The chief task of this organization was not only to design a great number of vast plants but, at the same time, to develop design methods and a design organization which gradually could be taken over by the Russians themselves. For a number of years I served as individual engineer in the Sverdlovsk branch of this organization, at a time when almost all of the original Albert Kahn men had left for home.

Design and construction in Russia was very different from anything we are used to in this country. The extreme shortage of steel compelled the use of reinforced concrete and timber in places where they would hardly be used under normal circumstances. The framework of almost any plant, (columns, girders, beams) was invariably built in reinforced concrete and long span roofs, wherever possible (and frequently even where impossible) of timber. Even open-hearth plants with their inevitable fire-hazard were covered by timber roofs, with the possibility of later replacement by fireproof roofing being incorporated in the design. The roof itself consisted of what was called a "timber slab," two-by-fours layed solid, side by side. Such heavy roofing was necessary to counteract the extreme conditions of condensation inevitable in the severe northern climate. Even so, a number of roofs, particularly truss joints, sagged or failed by decay—sometimes even before the plant went into production.

"Hothouses"

The short duration of the frost-free building season would have dictated a much slower progress of construction than was acceptable within the framework of the sharply accelerated plan of industrialization of the country. For that reason, wherever possible, huge plywood "hothouses" were erected in the fall covering the entire site of the particular building. These hothouses would be heated in the winter by make-shift heating plants, and construction would proceed the year round. There was a limit to which one could go in such "hothousing" as far as overall dimensions of buildings were concerned. In order not to be tied by such limits, two other methods were employed for winter construction in addition to the usual, but insufficient, pre-heating of water and aggregate. One was the extensive use of prefabricated concrete elements.

Precast reinforced concrete T-columns supporting timber roof frames. Note brackets for installation of precast crane runway girders. Sverdlovsc, U.S.S.R.

Such elements were used not only in small units, as they are in this country, but huge columns, beams,

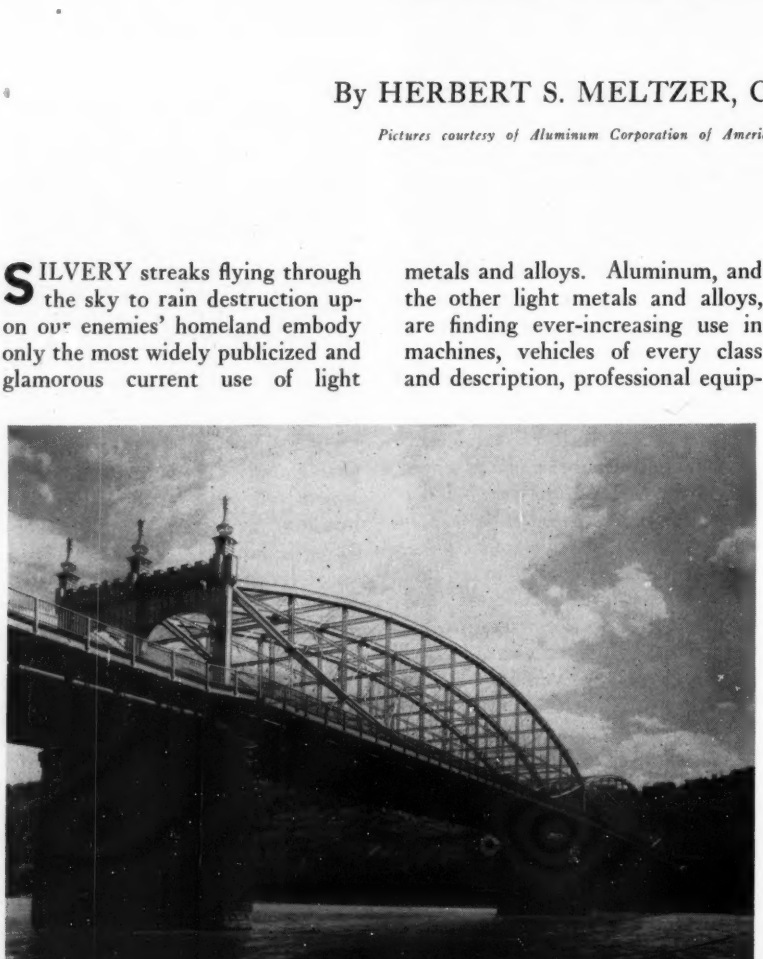
(Continued on page 34)

ALUMINUM --- STRUCTURAL METAL OF THE FUTURE

By HERBERT S. MELTZER, CE '47

Pictures courtesy of Aluminum Corporation of America

SILVERY streaks flying through the sky to rain destruction upon our enemies' homeland embody only the most widely publicized and glamorous current use of light metals and alloys. Aluminum, and the other light metals and alloys, are finding ever-increasing use in machines, vehicles of every class and description, professional equipment, and consumer goods. Limited at present by war demands, these metals will soon be used in ever-increasing numbers and varities of goods.



The Smithfield Street Bridge, Pittsburgh, showing the aluminum flooring system installed in 1933.

TABLE I

PHYSICAL PROPERTIES OF ALUMINUM ALLOYS COMPARED WITH STEEL

Property	*Duralumin 17S-T*	*27S-T*	*Structural Steel*
Unit weight	175 pcf	175 pcf	490 pcf
Moduuls of elasticity	10,400,000 psi	10,400,000 psi	29,000,000 psi
Ultimate tensile strength	60,000 psi	65,000 psi	65,000 psi
Yield tensile strength	37,000 psi	50,000 psi	33,000 psi
Ultimate shear strength	36,000 psi	39,000 psi	48,000 psi
Allowable tensile stress	17,000 psi	21,000 psi	20,000 psi
Unit working stress*	1,390 lbs	1,720 lbs	590 lbs
Endurance limit	15,000 psi	13,000 psi	33,000 psi
Elongation in 2 inches	22 %	11 %	22 %
Brinell hardness number	100	115	110-130

**The allowable tensile stress a one-pound bar one foot long may carry.*

Economically, steel is at present irreplaceable in the prosaic field of static structures. Costing a fraction of the price of other metals, its physical properties make it the most widely used of metals where light weight is not essential. In skyscrapers, on railroad beds, for concrete reinforcement: here, the high modulus of elasticity as well as low cost make steel indispensable. But the value of aluminum, combining light weight and corrosion resistance, makes the metal economically practical and desirable in such structures as bridge floors, roofs, bulkheads, or dam locks.

Properties

Aluminum, commercially pure, has poor structural properties. However, alloys of this metal (which is what "aluminum" will indicate in this article), composed of 90 to 95 per cent aluminum to which are added copper, silicon, manganese, or magnesium, have many structural applications. The hot, plastic metal may be rolled or extruded, extrusion resulting in stronger members, and then heat treated. The final products, alloys 17S-T (duralumin), 27S-T, 75S-T, and other newly developed metals, have physical properties akin to structural steel. For comparison of these two materials see Table I.

Aluminum is available at present in almost all structural shapes and

dimensions, including angles, I-beams, channels, H-beams, tees, and zees. The "Structural Aluminum Handbook" lists these shapes in all structural sizes up to 10-inch channels, 12-inch beams, and 6x6-inch angles.

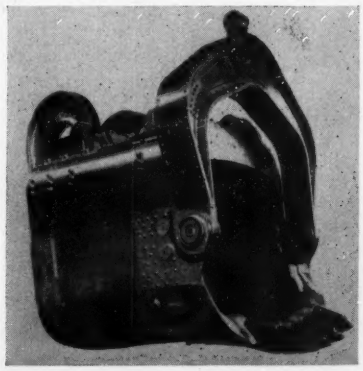
Deflection

Because of its low modulus of elasticity, 10,400,000 psi, compared to 29,000,000 for steel, an aluminum member will deflect three times as much as a steel member of the same strength. This is undesirable in many cases, prohibited by specifications in some. As deflection is inversely proportional to the cube of the depth (or the moment of inertia about the centroidal axis), increasing the depth by 1.45 (or the moment of inertia by three) results in a structure of satisfactory stiffness. Yet the saving in weight is still greater than one third for a solid section, considerably more for a structural shape.

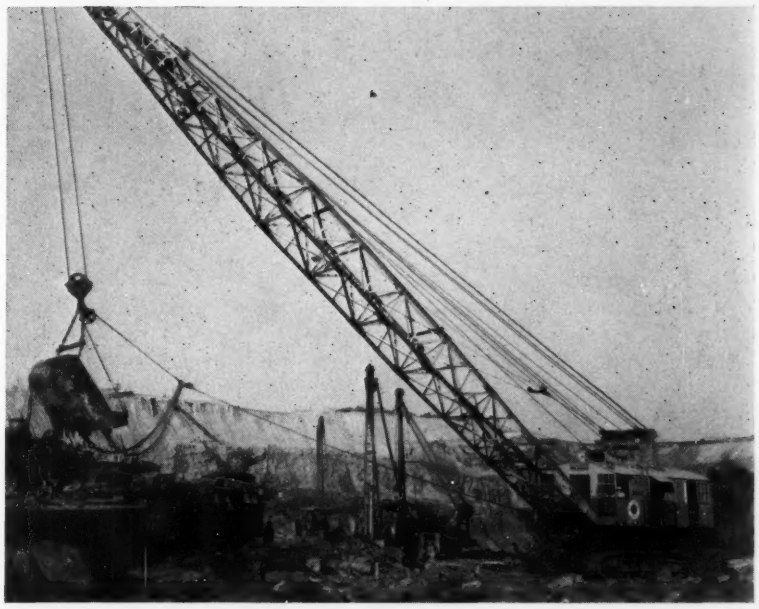
Design Factors

Design procedures and specifications for aluminum are almost identical with those for steel. Factors which must be taken into account include the low modulus of elasticity, modifying column and other formulas, and the low fatigue resistance, for which allowance must be made by lowering the working stress for members subjected to repeated loads.

Methods of assembly are simplified by the light weight; often it is possible for one or two men to carry a section for which a crane would have to be used if the section were steel. While it may be riveted or bolted, neither burning nor welding should be done on aluminum members subject to loads; burning leaves very ragged edges, while welding destroys the strength gained from extrusion and heat treatment in manufacture. Drilling, reaming, and punching are performed more easily and quickly on aluminum than on steel; but shearing may be more difficult.



Lightweight aluminum excavator bucket has greater capacity than steel bucket of the same weight.



Drag-line excavator with 150-foot aluminum boom. Light weight permits greater reach and heavier loads without upsetting the vehicle.

Actual Application

An appreciation of the practical application of aluminum in structural work may be obtained by examining some aluminum structures. The first important application to bridge building was the reconstruction of the Smithfield Street Bridge in Pittsburgh. Originally built across the Monangahela River, in 1882, by the 1920's the bridge was rated as obsolete and slated for replacement. Construction of other bridges nearby relieved the congestion and made repair feasible. After considerable study, it was decided that the use of aluminum for a new floor system would relieve the overstress of the trusses by reducing the dead load, and also provide a permanent, hard-surfaced roadway floor which would give satisfactory service for many years.

Consequently, in 1933, the entire floor system of the bridge was reconstructed using aluminum members designed and built quite like steel members, and using similar methods of construction facilitated by simplified handling of the lighter sections. The heavy timbered floor of the old roadway was replaced with a battledeck type of floor constructed wholly of aluminum and topped with an asphaltic surfacing. Altogether, the deck slab weighed only 30 pounds per square foot, giving a net reduction of 750 tons of dead weight (65 per cent) to the structure. The permissible loading was increased from 13 to 20 tons for a four-wheeled vehicle, while the 50-foot interval formerly required between trolleys was eliminated.

New Floor

The original floor designs were developed for alloy 17S-T; however, alloy 27S-T, newly developed, was ultimately used because of the latter's greater resistance to corrosion and its superior physical properties. No change was made in the design, however, thereby giving an even larger factor of safety. The design stress was fixed at 15,000 psi in tension, with necessary reductions for unsupported length in compression as computed by ordinary column formulas. In a report on the bridge, Mr. Charles Reppert, chief engineer of the Pittsburgh Department of Public Works, stated that from an economical standpoint, deferring the replacement of the structure for an estimated 25 years

(Continued on page 38)

POWDER METALLURGY

By DONALD S. IRONSIDE, EE '46

All pictures courtesy of Chrysler Corporation

A FEW years ago, when war-driven American industry was feverishly trying to increase production, it developed terrific shortages in machines, materials, and men. As a result, factories were forced to experiment with many new and untried processes. One of these which has a promising future is the making of small and not-so-small parts from metal powders. A striking example of the overnight development of this technique was the Army-sponsored attempt, in 1942, to produce tank-busting .50 caliber machine-gun bullets from iron powder. Although these bullets could not quite pierce half-inch armor plate, as their high-carbon steel counterparts had done before, the mere attempt was enough to show that powder metallurgy is a process to be reckoned with.

For the purpose of this article, powder metallurgy may be defined as the art of making solid or porous metallic parts from metal powders, or mixtures of metal and non-metal powders. In general, this process consists of four steps: producing powder, molding, sintering, and finishing.

Powder production is carried on by two major methods, although many others are in use. These are (1) reduction of finely ground ore in carbon monoxide or hydrogen gas; and (2) electrolytic deposition of the metal, much as in electroplating—except that here special pains are taken to produce a flaky or spongy deposit.

Molding is a simple operation in which powder is poured into a die and compressed to shape in a hydraulic or mechanical press. The compact so formed is quite strong enough to hold its shape during sintering.

Sintering consists of heating the compact for a short time to a temperature somewhat below the melting point. After sintering, the compact will retain its shape and the individual particles will be found to be welded together, forming a strong, hard mass. This process is the "magic" of powder metallurgy. No sound scientific explanation for it has yet been proven .

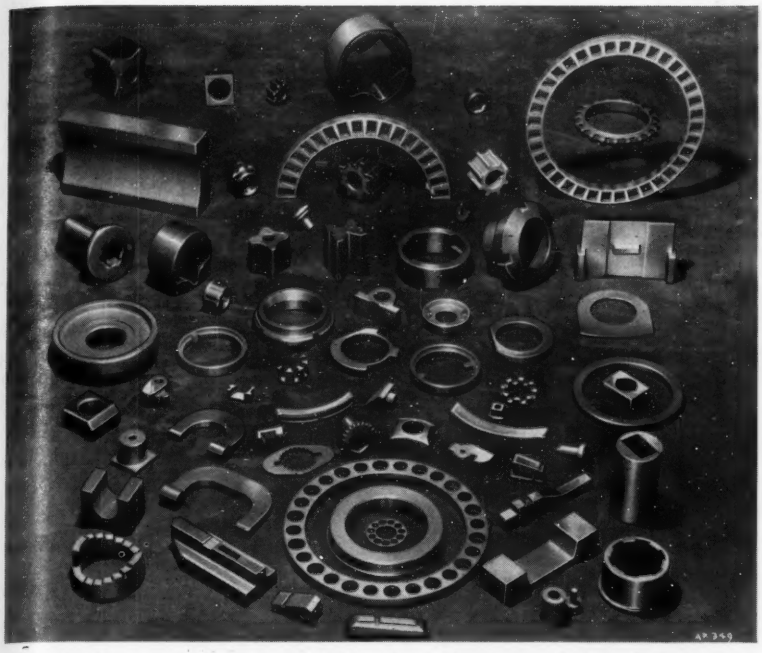
Finishing may consist of repressing for close dimensions, or some small machining operations. Many products require no finishing at all.

Solid or semi-solid metals made from powder date back to 3000 B.C. in Egypt. The Egyptians, unable to melt iron, hammered small particles into a conglomeration which served them for tools. Various other metals were fabricated in similar manner up to about 1850, but by that time furnace temperatures were high enough that all these metals could be fabricated much more satisfactorily by melting and hot working methods. Powder metallurgy was forgotten.

For the modern renaissance of powder metallurgy, we have to go back just forty years. In 1905, Edison's incandescent lamps were being produced in large numbers,

A briquetting press showing parts of intricate shape being mass produced by the powdered metal technique in a nine second cycle.

Close-up of the table of a briquetting press showing a part being ejected from the die.



Machine parts made up to 200 times faster than by standard methods by Chrysler Corporation from metal powders.

but the filament then used was so unsatisfactory, that the makers were afraid of competition from the gas-filled glow lamp which was then being introduced. None of the filaments then in use could stand up under the high temperatures required for efficient operation. At this critical time, Dr. William D. Coolidge set to work to produce a filament made of tungsten. He knew that this metal could stand the high temperature—in fact, tungsten was so obstinate when heated that it had never been worked into any useful form. It existed only as a powder, and this Coolidge hoped to make into a fine wire. In 1911 General Electric Co. testified to his success by scrapping a million dollars worth of now obsolete machines and stock to make way for production of Coolidge's new tungsten filament. Coolidge had produced the first ductile tungsten in history from pressed tungsten powder. His process is still used in production of tungsten and has been adapted to other refractory metals, such as molybdenum and tantalum. It consists of pressing and sintering a small rod of the metal, followed by pounding to reduce the diameter, and drawing through successively smaller dies until a fine, ductile wire is produced, having a tensile strength of 500,000 psi. Filaments so produced are used in every incandescent lamp and vacuum tube made today. Operation of radio, long distance telephone, and other electronic devices would be very difficult without this first produce of powder metallurgy.

Developments

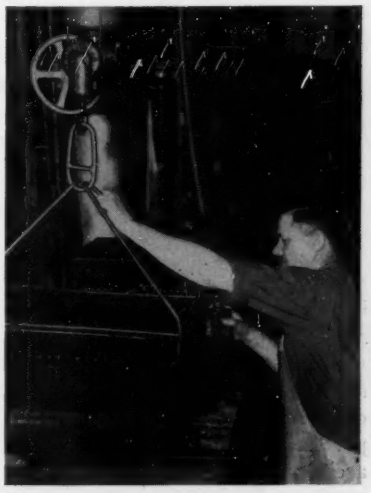
Since Coolidge's discovery, technologists have brought forth several developments so valuable to industry that powder metallurgy is now considered indispensable. The first and most well-known of these developments, the so-called oilless bearing, came around the close of World War I. It was found that excellent cylindrical bearings could be made of mixed copper, tin, and zinc powders. These are purposely made very porous so that they can be impregnated with oil to about thirty per cent of their total volume. This oil expands when the bearing heats up and flows to the surface where it acts as a lubricant. Such bearings are now made up to sixty pounds in weight and require no maintenance throughout their life. They are especially useful in autos, and home and farm machines where owners are likely to be careless about oiling; and in airplanes, where porous bearings have special advantages in high altitude operation.

A few years after the porous bearing there appeared carbide tools made from a mixture of cobalt and tungsten carbide powders. It may be interesting to note that these were developed as a cheap substitute for the diamond dies which were originally used in the drawing of tungsten wire. Carbide tools will cut twelve times as fast as the best high speed steel; carbide dies have life up to sixty times as long as the best steel dies. Both are indispensable to our high rate of war production.

One of the outstanding results of research in powder metallurgy has been the discovery that when two or more metal powders are mixed in a compact, the product may retain the properties of *both* constituent metals. Such an alloy is not obtainable by any other method—when two metals are fused together as in ordinary practice, they form an alloy having entirely new properties. Furthermore, two metals which will not even mix in the fused state can be combined by powder processes to form a homogeneous product. These properties are best illustrated in manufacture of electrical contacts. Such contacts must be of low electrical resistance, and the surface must stay smooth and bright in spite of the high temperature electric arc which occurs every time the contact is opened. These properties are not to be found together in any known metals or fused alloy, but are fully satisfied by pressed silver and tungsten powders. The silver accounts for low

(Continued on page 40)

These self-lubricating Oilite Flange Bearings are made of 30% porous, metallic sponge.



SOME USEFUL LABORATORY GADGETS

By ROBERT H. OLSON, ChemE '46

IN almost every laboratory course there are developed, from time to time, pieces of apparatus or methods for the analysis of experimental data that are different from those described in the text books or technical journals. Although these may not be truly novel in conception or radically new in design, they may have sufficient novelty and utility to make them of interest outside the specific course in which they were developed. In this article are described some of the devices used in the laboratory of Chemical Engineering at Cornell.

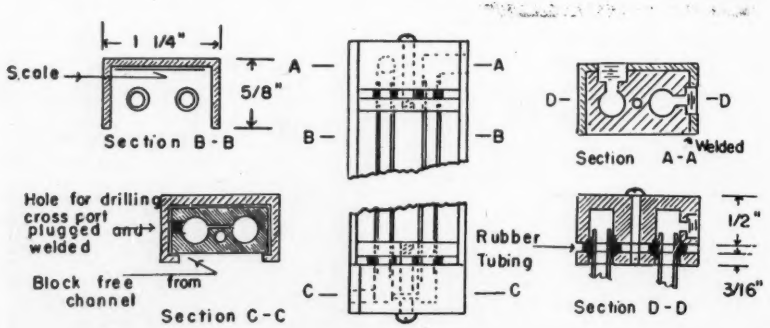
Manometer

In most engineering laboratories there is frequent need for manometers for measuring pressure differences ranging from a few inches of water to several feet of mercury. These should be relatively inexpensive and of such design that they can be made by any mechanic of ordinary skill, with tools available in almost any shop. It should be possible to remove and re-install the tubes easily and quickly to facilitate cleaning and repair. The construction should be such as to protect the tubes effectively from accidental breakage or from stresses set up by changes in temperature.

The manometers commonly used in the chemical engineering laboratories are constructed as follows:

The frame is a vertical steel channel bar 1½ inch wide and ⅜ inch deep and of length suitable to the range of pressures to be measured. Two vertical glass tubes, each about ¼ inch in external diameter, are placed in the channel and held between a steel head-block and a steel tail-block as shown in Figure 1. A scale is attached to the channel bar back of the tubes.

The head-block is made from a block of steel ½ inch high and of such length and width as to fit into the channel. At the back and ends it is welded to the channel bar. In this block, two vertical holes 9/32 inch in diameter are bored upward from the bottom to terminate ⅛ inch below the top. The lower end of each of these holes is reamed. Into the left-hand hole is drilled, from the back, a horizontal threaded opening into which is screwed a ⅛-inch steel nipple connecting with one of the pressure lines. Into the right-hand hole is drilled, from the side of the channel iron, a threaded opening to receive a ⅛-inch steel nipple connecting with the other pressure line. Through the center of the block is drilled a small vertical hole slightly larger than a ⅛-inch brass screw.



MANOMETER
Figure 1

Below the fixed head-block is a 3/16-inch steel plate of such size as to move freely in the channel, with two vertical 9/32-inch holes to match those in the head-block. The upper end of each hole is reamed. The plate also carries a central vertical hole threaded to receive a ⅛-inch brass screw.

The upper end of each glass manometer tube extends through the movable plate and into the hole in the fixed block. A short collar of rubber tubing is fitted over each tube between the block and the head. The rubber is compressed to form a tight gasket by drawing the movable plate up against the head-block with the brass screw.

The tail-block is, in general, arranged like the head-block; it is not, however, welded to the channel-bar frame but is suspended from the glass tubes. To prevent the tail-block from swinging outward, a narrow lip is welded to the front edge of each side of the channel-bar. The two holes in the tail-block are connected by a transverse opening 1/32 inch in diameter. This is drilled off center, to cut into the holes at their back edges. This is done to avoid interference with the vertical hole for the tightening screw. To facilitate drilling this connecting port, a ⅛-inch hole is drilled in from the side of the channel. This is sealed shut after the cross port is drilled. It is important that the opening for the screws that hold the movable plates against the blocks be central with respect to the upper surface of the plate; if the holes are not central, tightening the screw tends to twist the plate so that it does not compress the gaskets uniformly.

In assembling these manometers,

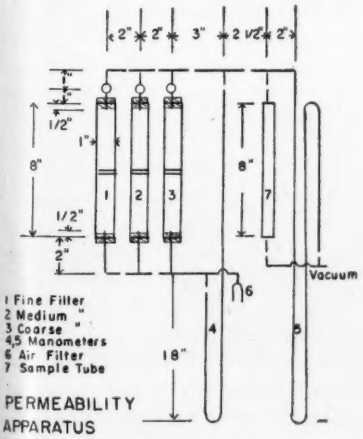
the glass tubes, cut to the length of the channel-iron, are placed in the tail-block, and the movable plate screwed down to seal the joints. The manometer fluid is added and the tubes are then placed into the channel-bar with the upper ends fitted into the head-block. The upper movable plate is drawn up to make tight joints and to hold the manometer tubes in place.

Measurement of Specific Surface

In the examination of fine powders, as, for example, ground rock or Portland cement, it is often desirable to estimate the size-distribution relationships in the range below the size corresponding to a 200-mesh sieve, or to determine the specific surface of a powder. One method for finding specific surface is to measure the resistance offered to the flow of air through a column of the fine material.

The apparatus used consists of a vertical tube of known dimensions connected in series with a fritted glass disk of known permeability. One differential manometer is connected across the tube; another is connected across the disk. A weighed sample of the powder to be tested is packed into the tube and the height of the column of packed material is measured. Air is drawn through the sample and the disk in series, at a known rate indicated by the manometer across the disk. From the measured pressure drop through the sample, the weight of the sample, and the dimensions of the column of packed sample in the tube, the specific surface is completed.

The details of the sample tube are shown in Figure 2. The sample tube is a brass tube ¾ inch in external diameter, ⅜ inch in internal diameter, and 10¼ inches long. It consists of three sections: a central cylindrical section 8 inches long and a cap at each end. The central section is threaded for a distance of ¼ inch on each end, and screws tightly into an interior thread in the cap. Each cap is 1⅛ inch long, and terminates in a ¼-inch brass tube 1 inch long. A circle of 65-mesh screen is held firmly between the bottom of the central section and the shoulder on the lower cap.



Three stndard disks of fritted glass (Eimer and Amend Cat. No. 11-136), of fine, medium, and coarse texture respectively, are connected in parallel with the sample tube. Each disk is 20 centimeters in diameter and is sealed transversely in a 1-inch glass tube extending 4 inches above and 4 inches below the disk. The lower ends of all three tubes are connected in parallel with a common inlet line terminating in an air filter. The air filter is a paper extraction thimble, attached to the end of the inlet. The connections from the inlet tubes to the tubes containing the fritted glass disks are by rubber stoppers.

Connections

The tops of the tubes are connected in parallel, through stopcocks, with a common outlet line, so that air can be drawn through each tube separately. A water-filled manometer is attached between the inlet manifold and the outlet manifold.

The lower (outlet) connection from the sample tube is connected to a vacuum pump. A water-filled manometer is connected between the inlet and outlet of the sample tube.

All connecting lines are of 7-millimeter glass tubing.

By connecting in parallel the three fritted disks of different porosities, the range of the apparatus is extended so that samples of widely different permeability may be tested without extreme pressure differences on either manometer.

Each of the three fritted glass disks is separately calibrated to correlate the rate of flow of air through the disk and the pressure drop across it. Several measurements are made, at each of several rates of flow. No disk should be used at any flow rate above that at which the ratio between the rate of flow and the pressure drop ceases to be linear.

The rate of flow for any one disk, within the range for which the disk

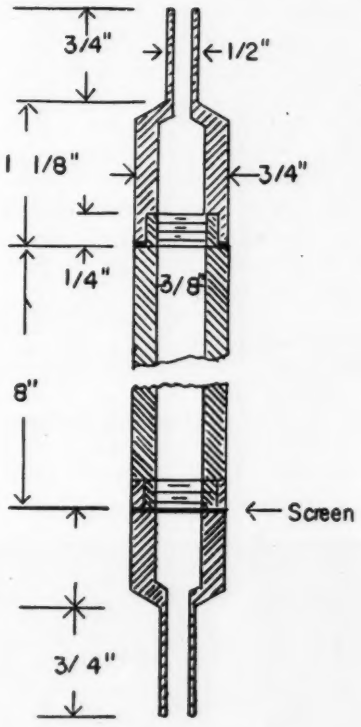


Figure 2

may be used, is represented by an equation of the form:

$Q = k\sqrt{h}$

where

Q=flow rate, cc/sec
k=correlation constant
h=differential pressure, cm water

In measuring the specific surface of a *sized* sample, as, for example, the fraction of crushed sand that passes a 100-mesh sieve and is retained in a 150-mesh sieve, the sample is first washed to remove any very fine adhering dust and is then dried. Unsized powders, as, for example, the 200-mesh fraction, are not washed.

The procedure in measuring specific surface is as follows:

The upper cap is removed, and the tube is clamped vertically, with the end of the lower outlet tube about ⅛ inch above a sheet of glazed paper on the desk top. Ten grams of the dry sample are weighed

(Continued on page 32)

Engineering At Cornell

7. Materials Testing Laboratory

By ANTHONY S. RUGARE, ME '47

ANYONE who has ever visited the materials laboratory located in the East Mechanical Laboratory building during the course of an experiment might speak of his visit thus:

'Twas the time before rupture,
when all through the lab,
Not a student was stirring, but
those keeping tab.
The specimen was clasped in the
Olsen with care,
The power applied made the load
hard to bear.
The V-12'ers about it were clustered
in awe,
Thoughts of reports made them
hate what they saw.

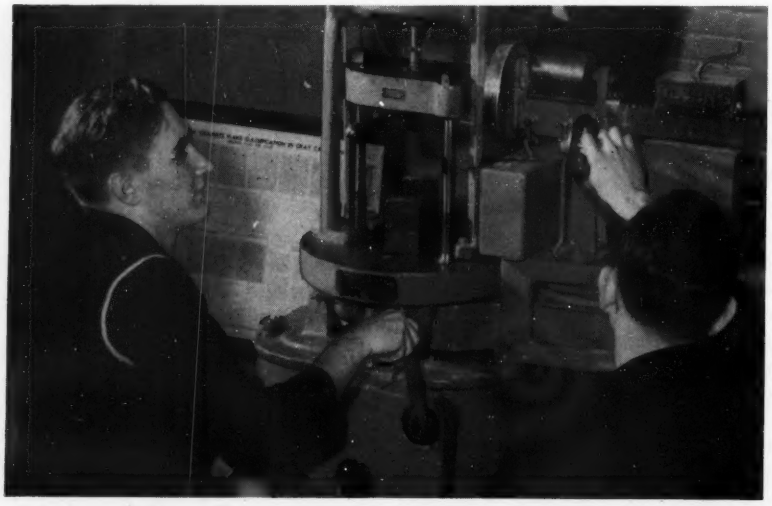


Photo by Knight

A manually balanced Olsen testing machine being used for tension tests on a Dow metal specimen.

And the sailors in blue, and a
civilian, the sap,
Had just settled their brains for a
few minutes nap;
When all of a sudden there came
the big noise,
V-12'ers, civilian—they all lost their
poise.

It is the big noise referred to which emphatically introduces materials testing laboratory to ME's, EE's, and ChemE's. For those not privileged to be subjected to materials lab it might be well to say that the big noise comes as the result of a steel specimen rupturing in a testing machine.

The testing of a steel specimen plays an important role in engineering. A machine can be correctly designed according to engineering principles and formulae, but the selection of proper materials for the actual construction will determine the efficiency, maintenance, and life of the product. The purpose of the courses offered by the materials department is to acquaint students with the properties and methods of selection of engineering materials, and also to familiarize them with testing procedures. The materials testing courses offered are known as 3T31 and 3T32. The first is devoted to metals and alloys and is taken by ME's, ChemE's, and EE's, while the second, devoted to nonmetallic materials, is required only of ME's.

It was not until 1942 that engineering materials testing was raised to the rank of a department in the ME school. Previously, the Department of Engineering Materials was a part of the Department of Experimental Engineering. As a course, materials laboratory stems from the engineering laboratories which Robert Henry Thurston established at Cornell when he came to the University as Director of Sibley College in 1885. Thurston, who had previously organized a pioneer laboratory at Stevens Institute, developed his program at Cornell and, by insisting on the importance of laboratory study of machines and materials, helped change the course of engineering education in the United States. Through the years, the materials testing lab has grown so that it now is equipped for tension, transverse, and compression tests with the most modern testing machines.

Tension Tests

With the aid of the hydraulic Olsen 200,000 lb. testing machine, students can run tension tests on heavy 12 in. long specimens. An Amsler 100,000 lb. hydraulic machine is usually used to perform compression tests but can also be used to run tension tests. For fatigue tests, the student can turn to either an Upton-Lewis machine or a R. R. Moore fatigue tester. Those desiring to perform an impact test find an Amsler-Charpy-Izod testing machine handy. There is also in the lab an Olsen torsion machine of 140,000 in.-lb. capacity which twists steel specimens until failure. Another popular machine is the one used to run transverse tests. This machine was made out of platform scales. Other equipment in the lab includes hardness testing machines, metallographic microscopes, polishing equipment, extensometers, gas and electric furnaces, tempering baths and photographic apparatus.

In addition there is a fuel laboratory for fuel analysis and calorimetry, an oil lab for determining the properties of oils and their behavior in bearings, and a C.F.R. en-

gine for determining gasoline octane ratings.

Introduction

Materials laboratory (the term materials lab is used in spite of the insistence of many juniors to refer to it as "mech lab") is no engineering wilderness to entering students. Most of them have already been exposed to Professor Jeffrey's 3T21 and some of them also have 3T22 under their belts. These courses furnish an introduction to the actual testing of engineering materials and the determination of their properties; so the student entering the course is able to feel that here is a place to put some lecture knowledge to practical use in a lab. The terms equilibrium diagram, austenite, ferrite, alloy steel, cellulose acetate, lucite, and SAE 20 oil all have a familiar ring to him during the progress of an experiment, although by some sort of psychological reaction, they are often completely foreign to him during a prelim.

Prepared with knowledge secured in other courses and that secured in weekly recitations, the student performs the week's experiment. There are about 10 experiments per term, and each instructor usually has charge of two or three tests. Besides the common tension, transverse, and compression tests, the student performs such relatively new tests as fatigue tests and Jominy harderability tests. It was only a few years ago that the Jominy test became widely accepted; but today it plays a major role in the field of engineering materials. In main, the test consists of spraying a jet of water upon the end of a hot steel specimen, and then taking hardness readings along the surface of the specimen, various points of which have been subjected to different cooling rates. After performing this test the student has a more vivid view of hardenability and its importance.

Photo by Knight

Studying the structure of a steel with a metallographic microscope.

Also along modern lines is the experiment on metallography, a science which helps the engineer predict the properties of engineering materials without actually testing them. During the course of this experiment, the student prepares a specimen to be examined under a metallographic microscope and then attempts to distinguish the various constituents present in the specimen. Another prominent part of this experiment is a demonstration by the instructor of the spectrographic analysis of metals.

Acquaintance

Because of the nature of the experiments, the student unconsciously becomes acquainted with a great variety of engineering materials. Steels and cast irons are used for most of the tests, but copper, brasses, bronzes, and aluminum and magnesium alloys are also frequently handled.

Materials testing lab is not entirely devoted to metals and alloys. The second semester dealing with non-metallic materials proves just as interesting as the first. Anyone who has driven a "jalopy" and attributed many of its faults to the low octane gas he was forced to use finds the knock testing experiment especially interesting. By using a single cylinder C.F.R. engine, students can determine the octane rating of any gasoline. After this experiment the driver of the jalopy can argue more effectively.

One thing which the student particularly notices during this course is that much of the apparatus used has been developed at Cornell. To find how the viscosity of an oil will vary with temperature, a Cornell viscosimeter is used. In order to determine the flash and fire points of oils, a Sibley Open Cup is employed. One of the larger pieces of apparatus is the machine developed by Robert Thurston for determining the behavior of oils in bearings.

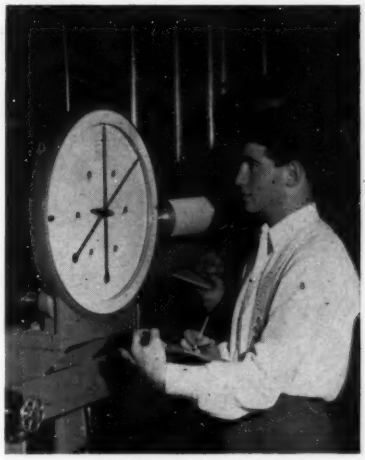


Photo by Detuch

Taking data from an Amsler Universal testing machine during a compression test.

Petroleum products, however, are not the only materials investigated in 3T32. Due to the increasing importance of plastics, an experiment is devoted to the testing of plastics. The properties of more common materials such as wood and concrete are also investigated.

Besides performing the usual function of imparting knowledge, experiments also often provide a few laughs. For instance, during a tension or transverse test a student will sit anxiously staring at the needle of an extensometer wondering why it is not moving only to find that the meter exceeded its range and that the test piece is about to rupture. Then there is the student who knows how to get the machine started but when the time comes to stop it he finds that he was not paying attention when the instructor explained this operation—tough on the machines! Not to be overlooked are the many times when the person running off computations with his beloved slide rule works to the bottom of a column of data only to find that his units are slightly mixed up, or when one of the partners suddenly remembers that he did not measure the dimensions of the test piece which is now in two pieces.

But in spite of setbacks, a data sheet is finally obtained and all that remains is to write a report on the

(Continued on page 48)

PROMINENT

"Pipes"

Harry C. Moore, Jr., ME '46

WHY Harry C. Moore, Jr. is called "Pipes" is a rather debatable question. The fact that his father was engaged in pre-war plumbing engineering before becoming a Lieutenant Commander in the Navy may have something to do with it. At any rate, that guy behind the big smile and under the receding hair line is well known on the campus as just plain "Pipes".

Moore (Jr.) conditioned himself for engineering during three summers in a construction company, progressing from time keeper to truck driver in that short interval. His collegiate activities prove that the experience must have been beneficial. During the cooler months of those years, he studied at the Atlantic City High School, while developing his renowned social compatability. He emerged from his secondary school education with a very creditable record.

In September, 1942, "Pipes" was in that tremendous, though now diminutive class of '46, who frolicked at Lake Keuka, absorbing knowledge of the traditions, customs, and activities of Cornell in the last Frosh Camp to be held. He came to Cornell for several reasons. In the first place he says, "It's the best darn school in the world!" His father, class of '18, had driven that home. "Pipes" had heard some rather torrid tales of Cornell houseparties, wanted to make sure for himself, and didn't believe any uncomplementary stories about the co-eds. Upon visiting the campus in July '41, he was completely sold on the place.

In his first year "Pipes" went out for frosh crew, but modestly claims he "wasn't so hot." Although his tiring efforts were not particularly fruitful, his desire to get out on the lake and out of P.T. was sufficiently strong to make him go out for crew manager. Here he established himself as one of the meanest launch drivers in crew history, keeping "The Big Red" at dangerously close quarters with never a mishap. "Pipes" blames his receding forehead on the irregular course of, his pride and joy, the crew shells. He stoically asserts, "Coxs are just born with no brains." For the past year "Pipes" has been a chief policy-maker in the Crew Club. The latest hair shaves of all frosh oarsmen attest to his influence.

During his freshman year he was initiated into Alpha Sigma Phi fraternity, of which his father was also a member. For the past two terms "Pipes" has been secretary of ASME and was recently appointed to the election board of the Student Council. He is also one of the older student members of Atmos, Mechanical Engineering honorary society. Not to be forgotten among Harry's extra-curricular atcivities is his esteemed position as Commodore of the noble order of Pi Beta Tau, in whose beer kegs he regularly makes a healthy dent.

As soon as possible, "Pipes" plans to resign from the Navy, return to Cornell for some business courses, and enter the field of refrigeration and air conditioning, (one of Larry Wright's boys).

When not occupied in one of the above diversions, Harry wants to sail, swim, catch every blue fish in the Atlantic, and enjoy the intellectual companionship of some lucky female, yet to be found.

Henry J. Gieseler, ME '46

"No matter from what angle you look at it there's really no better body builder than Mr. Cullen's Basic Physical Training." Thus stated Hank Gieseler as he climbed out of Uncle Norm Sonju's coaching launch after pacing the freshmen crews to Crowbar and back. Hank has been fooling around the boathouse since last spring and according to his own count has avoided at least 5500 pushups. "Just think," he exclaimed, "if P.T. classes were held 5 times a week, I could have missed 6750."

Before coming to Cornell, Hank had lived most of his life in Crestwood, New York. He attended Roosevelt High School in Yonkers where upon graduation he received the Bausch and Lomb Science Medal. Aside from his regular studies, Hank was a member of the Radio, Camera and German Clubs and was on the photography staff of his yearbook.

Realizing the advantages of a liberal education, Hank favored a University rather than an Engineering Institute. Three universities, Yale, Princeton and Cornell attracted his attention. Perhaps it was the coeds, and perhaps the N. Y. State Cornell Scholarship that influenced his final decision. Hank says it was a protest against his high school principal who had a bad habit of trying to send all the male graduates to Princeton. At any rate he finally decided upon Cornell.

"Cousin Guzzle", as he is sometimes called, came to Ithaca in the fall of '42 as a member of the vanishing class of '46. Not having fully

(Continued on page 30)

Hank

ENGINEERS

Gordon S. Smith, EE '46

ONCE upon a time in Milwaukee, Wis., some 21 odd years ago, Mr. Smith stopped pacing back and forth in the fathers' room of the maternity ward to hear the words "It's a Boy."—and what a boy it turned out to be! Gordon Scofield Smith was to turn out to be a most versatile and ingenious individual.

In high school Gordon (G.S. to his friends) turned his talents to photography and soon became the photography editor of his high school year book. It was also during this time that G. S.'s musical talents became known, with his playing of a trombone in a local dance orchestra. During the summers G. S. turned to business by becoming the successful manager of a refreshment concession at the beach. In spare time at home there were always a great many things to keep him busy. He began showing his ingenuity by building airplane gas-models and during the same period added to his accomplishments the building of several radios (they worked too). After acquiring the necessary dexterity in using the tools in his father's home workshop, G. S. took upon himself two of the most difficult tasks of his building career. First came the design and construction of a single-acting reciprocating steam engine the speed of which was 1600 RPM, but we don't mention its brake thermal efficiency—(anyway, nice accomplishment, eh!). Then the first real sign of Gordon's electrical engineering ability came when he dreamed up and built several universal ac-dc motors.

"G.S."

It was September 1942 when G. S. came to Cornell on a McMullen Regional Scholarship to become an electrical engineer. With the coming of the war G. S. apparently had a fairy godmother watching over him for he managed to stay at Cornell via V-12.

During his civilian days he was a member of Delta Chi and sincerely wishes he had seen more of fraternity life than that introductory year. He is now the corresponding secretary of Eta Kappa Nu, a member of Tau Beta Pi, and also a member of that prominent EE beer drinkers' fraternity, the Delta Club.

Among his extracurricular interests is flying. He has ten solo hours in his log book. G. S. also goes for camping and canoe trips.

At the end of this term Gordon will leave Cornell zealously clutching a BEE degree. His immediate future will be taken care of by Mr. Forrestal, but for when peace again shall reign, Gordon says, "I want to find a job at which I shall be able to handle men as well as electrons."

Calvin G. Brown, CE '46

ONE of the few remaining civilian members of the Freshman class of the Fall of 1942 is Calvin G. Brown, Senior CE. The main reason why Cal has been able to stay around for his full eight terms can be explained by his claim that he is one of the youngest men ever to graduate from Cornell (he was eighteen only a few months ago). No small part of his success is due, however, to his ability to keep up a good scholastic average, hang on to several scholarships, and at the same time participate in more than the usual number of extracurricular and social activities.

At the present time Cal hails from Buffalo, N. Y., but he spent most of his life in the country where

Cal

he passed through a parade of country schools and graduated, with honors, from the High School at Lancaster, N. Y.

Cal's choice of a college was influenced by a relative who told him about Cornell and about Civil Engineering. Cal thereupon equipped himself with a New York State War Orphan's Scholarship, a Cornell Tuition Scholarship, and a Cornell Club of Buffalo Scholarship loan, and set out for Ithaca, an act which he has never regretted. To quote him on this, he "found out, after becoming acquainted with the nature of other fields of engineering, that C.E. was just about the best choice he could have made." The fact that Cal had a McMullen War Scholarship for several terms shows how well he and Civil Engineering have gotten along.

Cal has left his mark outside the scholastic field at Cornell, too. He won both Freshman numerals and letter at track and is a member of Spiked Shoe, honorary track society, President of Pyramid, a Civil Engineering Social-Scholastic Society, and a member of Chi Epsilon, National C.E. honorary society. Cal was also Business Manager of the CORNELL ENGINEER and is now its Treasurer.

During his Sophomore year, Cal was President of his C.E. class and a member of the Civil Engineering Honor Committee. He believes that the present Civil Engineering honor system is "the best in the University for upholding and encouraging honor and integrity among students," and he strongly

(Continued on page 52)

NEWS OF THE COLLEGE

ASME

THE Cornell branch of the American Society of Mechanical Engineers heard a talk on Wednesday evening, April 18, by Mr. Carl Ashley, the director of developmental research of the Carrier Corportion in Syracuse, N. Y., on the topic, "The Industrial Application of Air Conditioning." Slides were shown illustrating the talk.

On April 27, Captain Strok, the son-in-law of Professor Perkins of the Mechanics Department, gave a talk on "Grasshoppers" as used in the Mediterranean. Captain Strok was a field artillery laisson officer in the Mediterranean region.

Vassar girl becomes Cornell Engineer. After attending two years at Vassar College as a Math Major, Rosemary Williamson, daughter of G. M. Williamson, '14, entered the School of Electrical Engineering where she is now in her fourth term.

On May 11 and May 25, speaking contests were held in which student members gave talks on technical subjects. The prize for the best speech was a Mark's Handbook and a Cornell Key properly inscribed with the recipient's name. Second prize consisted of a suitably inscribed Cornell Key.

A.S.M.E. will hold nominations for Chairman, Vice-Chairman, and Secretary-Treasurer on June 8. All interested are asked to contact Professor Lee. The final meeting of this term will be a social gathering at which there will be plenty of refreshments. Admission will be $.50. This event will take place June 15, just before final exams.

Al Djebar

AT the April meeting, Al Djebar, ChemE society, initiated John K. Davidson into membership. The initiating officers were Bryce MacDonald and Paul Atteridg.

On Saturday, April 28, a beer picnic at the old rifle range, with dates, was held by the group.

Tau Beta Pi

THE following men were elected into Tau Beta Pi on April 26, 1945:

Adams, M. C.
Bergen, J. P.
Collinson, J.
Craven, J. P.
Davidson, J. K.
Falk, J .W.
Fuller, O.
Holmberg, G. I.
MacDonald, B.
Miller, H.
Moore, C. G.
Rich, S.
Rumbold, S. G.
Scott, R. C.

The following two members of the engineering faculty and Tau Beta Pi Alumni were elected to the advisory board of the New York Delta chapter:

Prof. H. G. Smith, E.E.
Prof. C. E. O'Rourke, C.E.

Chi Epsilon

THE following men were initiated into Chi Epsilon, honorary Civil Engineering fraternity, on May 26:

Arthur W. Beale
John T. Collinson
Gilbert I. Holmberg
Francis C. S. Hung
William W. Phelps
Stuart H. Snyder

Following the initiation, the new members attended a banquet at the Alhambra, at which E. K. Graham, secretary of the University, was the guest speaker.

Sigma Xi

THE following men of the College of Engineering were initiated into the National Society of the Sigma Xi, honorary scientific society on May 23, 1945:

To Membership
George P. Baumann, ChemE
Walter C. Brandsma, ChemE
Frank W. Dittman, ChemE
Ernest K. Gatcombe, ME
Wilmer L. Kranich, ChemE

To Associate Membership
Joseph C. Logue, EE
Wallace H. Toole, ChemE

Following the initiation a banquet was held at Martha Van Rens-

(Continued on page 30)

Cornell University Placement Service

WILLARD STRAIGHT HALL, ITHACA 107 E. 48th ST., NEW YORK CITY

ALUMNI NEWS

JAMES C. ROCKWELL, M.E. '04, '07, the president of the Manila Electric Company, was among the Americans rescued from the Santo Tomas Japanese internment camp. Officers of the Manila Electric Company in this country have received a wire from General Douglas MacArthur stating that arrangements for Rockwell to return to the United States would be made at the earliest possible date. He is believed to be in good health considering his experience.

LORENZO D. SPEED, M.E. '05, *has retired as general plant manager of the Michigan Bell Telephone System, after thirty-nine years in the telephone business.*

ON January 30, LEON C. WELCH M.E. '06, manager of the lubricating and sales technical service department, addressed the Engineering Society on "Present and Future Developments in Lubrication."

NEWTON C. FARR, C.E. '09, *chairman of the Alumni Association on Alumni Trustee nominations, was unanimously elected president of Urban Land Institute on January 25 at the annual meeting of the board of trustees in Chicago, Ill. The senior partner of Farr & Co., Chicago, he has been in the real estate business for thirty-three years. He is now chairman of the Illinois USO and a trustee of the Illinois Institute of Technology, the Faulkner School, and the Lincoln Memorial University. In the Negro housing field, he has pioneered as a successful developer and has led the campaign of the National Association of Real Estate Boards to encourage entry into this field.*

ADRIAN HUGHES, M.E. '12, director of research for the Baltimore Transit Co., Baltimore, Md., has been named an industry panel member of the Third Regional War Labor Board.

EVERETT P. GOOCH, M.E. '14, *was appointed a staff assistant at headquarters of Industrial Accounts division, Pittsburgh, Pa., office of Westinghouse Electric & Manufacturing Co. He was formerly accounting manager for the transportation and generator division of the East Pittsburgh works.*

WILLIAM C. BLISS, M.E. '17, has been promoted to Colonel. He commands an Ordnance group of the US First Army in Belgium. His unit was recently cited by Lieutenant General Hodges for its part in resisting the German counter-offensive in the Ardennes.

COLONEL DAVID M. DUNNE, JR., '26 C.E. '28, *Engineer officer on the staff of Lieutenant General Robert L. Eichelberger, commanding general of the US Eighth Army, has been awarded the Bronze Star for "meritorious achievement in connection with military operations against the enemy in New Guinea and the Philippine Islands."*

LIEUTENANT RICHARD H. ADELSON USNR, B.S. in A.E. (M.E.) '42; on duty in the Pacific, has received a Commendation Ribbon "for outstanding service in the line of his profession while serving as a director officer of a heavy machine gun mount on an air craft carrier in the western Pacific." "When the ship was attacked by low flying enemy planes," the citation, which was signed by Admiral William F. Halsey reads, "He directed the fire of his mount with great accuracy, thereby assisting in the destruction of an enemy torpedo plane."

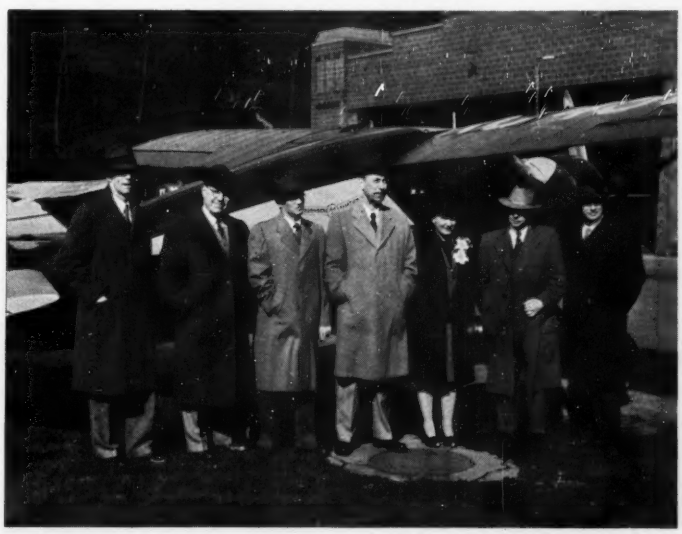
LEON S. EATON, M.E. '11, *was among those liberated from the Japanese internment camp at Los Banos. He was head of the department of Mechanical Engineering at the University of the Philippines when the islands were invaded in* 1941. *Mrs. Eaton has also been liberated and expects to return to the United States as soon as possible. Eaton, however, may remain if his services are needed.*

SHOWN in the accompanying picture are the guest passengers on the first flight, from Ithaca Airport April 6, of the Robinson Airline's new daily Ithaca-New York run. They are William B. Corcoran, '23, in charge of passenger operations here; Ralph C. Smith '15, executive secretary of the Ithaca Chamber of Commerce; City Engineer Leon H. Cass '28, Bernard M .Clarey '28, Ithaca Journal reporter and acting director of Athletics publicity; and Mrs. Gertrude Grover, daughter of the late Professor Herbert H. Whetzel, Plant Pathology, a reporter for University Station WHCU. Also pictured are Cecil S. Robinson, '21, president of Robinson Aviation, Inc., who piloted the first plane; and his chief pilot, Al Eager, who flew the second.

ALBERT J. JADOT, M.E., '23, is now located in Mons, Belgium, where, since his graduation from Cornell,

(Continued on page 30)

Robinson Airline's First Flight.



Dedicated to ye ancient and honourable society of ye chemical engineers in ye belief that Chemicale Engineering is ye one, ye only art.

"Caustic"

By JIM EDISON, ChemE, V-12

DE SONG OF DE CHAM HE

(*Witt no axcuses to Longfellow or eny udders*)

For ebuv Kayugah's wadder,
  For ebuv de wadder's billows,
Liffed a sed, sed race witt pipple.
  Liffffed a race onknun to pillows.
Liffed a race onknun to pillows,
  Or to matrissis or blenkets.
Liffed a race wott never slipping,
  Unly stodying de Pheesiks.
Unly witt de Mac Leb meking—
  Never witt de coads meking.

Liffed a sed, sed race witt pipple—
  Hair wot folling, ize wot strenning.
Midnight erl wot evar burning.
  (Not to menshun oll de lite-bolbs)
Worried witt prilims end witt finels
  Worried witt Feezikel Trenning.
Scared yet by Micro—det dred 5-thutty.
  Hahts wot wur sed; minds wot wur dutty.

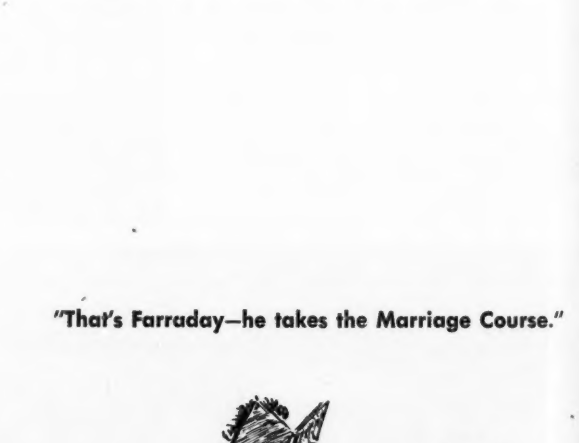
Liffed de sed Cham He's, daspicibel.
  Shonned by oll C He's, falicibel.
Shonned by He He's, end by coads.
  Luved by nun bot rets end toeds.
Woshipping he wot nemed wit Dosty.
  His eye yit shop—his thust wot losty.
Woshipping he wit gret hambishon—
  Woshipping he, gret God uf perdishun.

He, Big Chiff frum Holin, de tample.
  Voice so tuff, meks bege boys tremple.
Ahms are long end gretly riching,
  Cozzing moch bludshad end moch loud scriching.
Cozzing moch sorrow, wit no bit rejoicing.
  Cozzing much payn end tears to be voicing.
Cozzing yet swaring—moch threds wit slotter.
  Cozzing a weesh he'd ben born a dotter.
Cozzing moch cuzz wuds et Olma Motter.
  (Ken dees be sed of de 'Kintly Fotter"?)

Liffed de Cham He's—sed, hevvy leden.
  Luved by nun—nut a Cornell meden.
Dispized becuz of de stuping sulders
  (Sooch hevy buks—sooch well-filled fulders).
Dispized yet becuz of buddy hodors.
  (Becoz of no time to tek de bat with.)
Dispzied becoz soch minds lek modors.
  (Spanding to moch time to stody de mat wit.)

Fur ebuv Kayugah's wadder
  Liffed dis sed, sed race wit pipple.
Liffed did sed, sed, race wit Cham He's—
  Shonned by HeyHe's end by AmHe's
(With rispact from nun—nod ivin de NavE's)
Wit respacted from nun—so who's giving a dem?
  ChamHe's wots disared by de Oncle colled Sem.

"That's Farraday—he takes the Marriage Course."



PROFILES

Of Outstanding Alumni

Dr. Willis H. Carrier, M.E. '01

DR. Willis H. Carrier, chairman of the board of the Carrier Corporation, and the outstanding pioneer in the field of air-conditioning, has created a spirit in his organization that many others strive for, but few obtain. As a result, the Carrier Corporation is in several ways like a large family, guided through the years in its role as a producing unit by this natural leader.

Employees having lunch in the cafeteria of the Carrier Corporation in Syracuse, New York, may hear a familiar, hearty laugh; everyone feels a bit lighter, for someone has told "The Chief" a good story. His laugh is so contagious that all enjoy the joke, even though they don't hear it. It may be that a late-comer arrives in the cafeteria when it is almost deserted—but there are two engineers there in deep discussion with pencils at work on scrap paper or on the tablecloth. One of them is "The Chief", and you can be certain that some improvement in Carrier's air conditioning, refrigerating, or industrial heating equipment is under consideration. A visiting photographer wants a human interest picture of "The Chief"; so a trip is started with him through the Centrifugal Refrigerating Shop to get the shot, but it takes longer than one first imagines. The mechanics, the machinists, the welders—all stop him for a bit of conversation, a discussion of a detailed part of the machine, or merely the recollection of an old experience. The enjoyment and satisfaction of talking with "The Chief" is mutual, for he likes people and his genuine regard for the individual combined with his engineering ability gain for him the affection and respect of all Carrier employees — his fellow workers. The newcomer to Carrier Corporation may not know immediately that "The Chief" is Dr. Willis H. Carrier, Chairman of the Board of Carrier Corporation; but to the hundreds of "old timers" who have worked with the company for ten or fifteen years, and some for 25 or 30 years, "The Chief" is a personal friend, loved and respected by all.

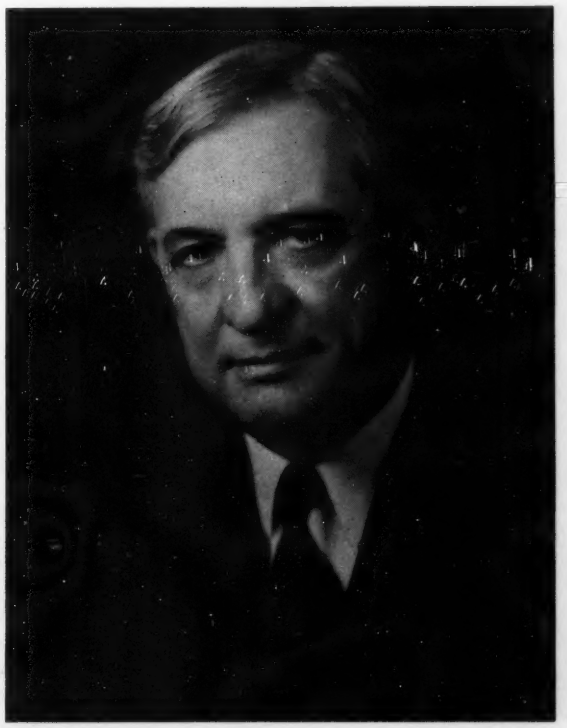
A visitor in the home of Mr. and Mrs. Willis H. Carrier will find him a thoughtful host, and her a charming hostess. Mrs. Carrier, formerly Elizabeth Wise, was an interior decorator before her marriage to Mr. Carrier, and her talents are evident in the selection of colors and furnishings in their home, and in her artistic flower arrangements. On spring days, early dinner guests may ramble along a trout stream, sit on a spacious veranda or view the hunting dogs while waiting for other guests to arrive. The atmosphere is one that encourages early arrival. If it is an evening of bridge, a good time will be enjoyed as Mr. Carrier loves the game and his enjoyment of the play is contagious. He is a good player, and one of the few who blames himself when cards do not fall right. He has been heard to say "If I were smarter, I'd have made that," and his friends who realize how "smart" he is are amused by the paradox.

Carriers' activities today continue as diversified as when he was a much younger man. In civic and community affairs, Willis H. Carrier takes an active part. He is on the Board of Syracuse YMCA, serves as Chairman of one of the Syracuse Selective Service Boards and participates in professional and social organizations in Syracuse and New York City. His business days are filled with engineering problems as they were with classes during school days. Sports again claim much of his leisure time. He is an enthusiastic golfer and an ardent hunter. Younger men who share playtime with him are forced to keep in training in order to keep pace with "The Chief".

Dr. Carrier was born November 26, 1876, in Angola, N. Y. He attended Buffalo Central High School and after receiving a state scholarship, entered Sibley College of Cornell University in 1897. He immediately took the University Scholarship Competitive Examination and was one of nine winners. Even though he was a working student, he was on the second freshman crew and participated in intramural crew races. He won laurels in a cross-country handicap, and was middleweight boxing champion in his Sophomore year. Classes and sports kept his days and evenings full, and Willis Carrier was acquiring scientific knowledge and a ruggedness in physique that has made possible his achievements in later life. In summer he worked, selling stereoscopic equipment and views that have adorned many library

(Continued on page 50)

Dr. Carrier



Recent Developments
In Engineering

Techni-Briefs

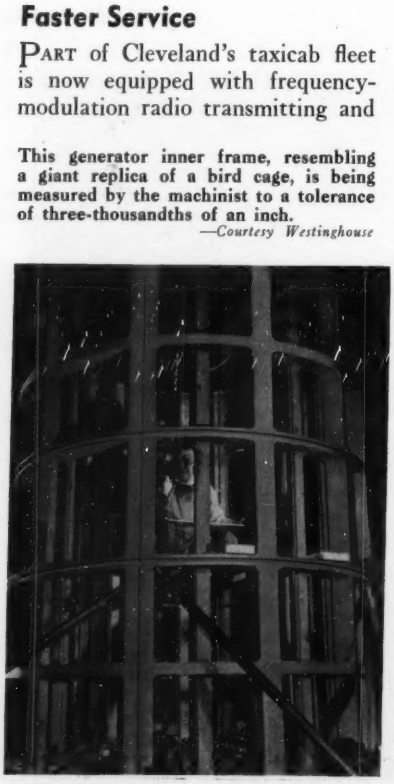
Lockheed P-80

THE new G-E Jet, most powerful aircraft engine in the world, feeds warm air to the pressurized cabin of the Army Air Forces Lockheed P-80 in addition to carrying out its major operation of driving this propellerless fighter faster than any other plane. The air flows from the impeller-compressor of the jet engine into the enclosed cabin where the pilot sits in relative comfort even when the plane is going at lightning speed in the substratosphere. Temperature of the air is controlled, making it unnecessary for the pilot to be dressed in heavy clothing. The pressurization of the cabin also makes it possible for the pilot to breathe normally at altitudes of six miles and more without even wearing an oxygen mask. This comfort, coupled with the lack of vibration, reduces pilot fatigue to a minimum.

Faster Service

PART of Cleveland's taxicab fleet is now equipped with frequency-modulation radio transmitting and receiving units for two-way communication between driver and dispatcher. Experience indicates greater efficiency of operation and faster service for the public.

This generator inner frame, resembling a giant replica of a bird cage, is being measured by the machinist to a tolerance of three-thousandths of an inch.
—Courtesy Westinghouse



Baby Bazooka

A new babyweight bazooka with a punch like Joe Louis and a new "eye" sight is now in production.

The new bazooka, made of aluminum instead of the previously used steel, is more accurate than its older brothers and weighs ten and one-half pounds (42% less than the old type.)

This is the seventh design of the weapon since the Army first submitted the plans for production in the spring of 1942.

The first model was a single piece barrel affair with sights similar to rifle sights. A second model was designed for paratroops and jungle warfare. It is a collapsible weapon which can be taken apart for easier handling. The latest model has an optical sight which provides an unrestricted view when leading fast moving targets. Though optical sights are not new, they require fairly complex engineering work to apply them to the bazooka. These sights increase the accuracy of the weapon so that a target may be pinpointed.

"Package" Plants

THE 3500 shp turbine, generator, and condenser, comprising the main power plant of a transport, can now be lowered into the engine room as a single "package". Built for installation on troopships and cargo vessels, the package is truly complete, even to the lubricating oil system, pumps, and piping. The only connections that need be made are those to the steam and water line and electrical connections.

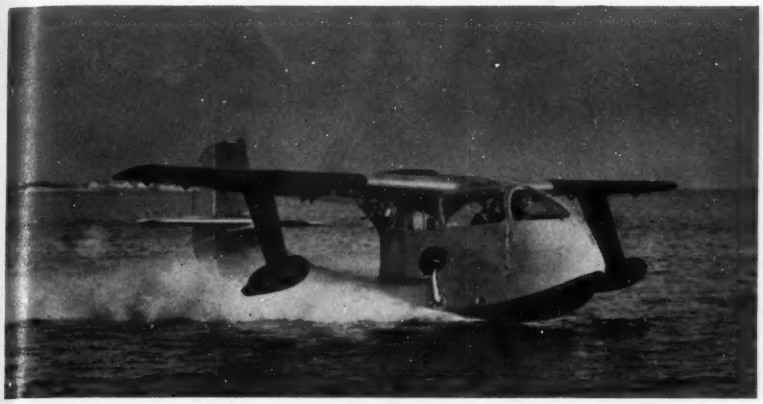
These new ships are twin screw, each shaft being turned by a 3300-hp slow speed synchronous motor and supplied with energy by one of the "package" power plants. Contributing to the small bulk of the power unit is the high speed, 4800 rpm, which means an 80-cycle, electrical system. Auxiliary power, predominantly alternating current, is provided by separate generating units.

—Courtesy Westinghouse
X-ray of a man shaving himself taken at 1/1,000,000 of a second in the Westinghouse Research Lamp Laboratories. The electric razor was operating with the motor making more than 116 revolutions per second. Research physicists say pictures may be made of larger motors too, even though they are covered with heavy metal.

The excitation for the generators, instead of being governed by the usual type of regulator, is under the control of a rotating regulator of the Rototrol type. This permits smaller normal excitation power (and excitation equipment) but provides a rapid boosting of excitation in emergencies, as during the increases in load that may appear in shallow water or in heavy storms. This system provides an automatic control of stability.

"Seabee"

AMONG the outstanding aircraft to be produced in the post-war period is Republic's all-metal amphibian, the "Seabee". The Seabee's cruising speed is 105 mph., and its tanks carry sufficient fuel to make a five-hour flight; thus its range is over



The "Seabee" is designed for easy take-off and landing on water as well as land.

500 miles. Its landing speed is 50 mph. On wheels, it stands 8 feet 7 inches high and is 26 feet 6 inches long. The side pontoons are attached to the single, 36 foot wing, and the 175 hp. pusher type Franklin Engine is mounted just behind the cabin in a sleek cowling which covers the wing attachments. The amphibian's hull, which is designed to permit easy landing or take-off from either land or water, sweeps back to a single-rudder tail. The spacious cabin will accommodate four passengers including luggage. On the instrument panel is mounted modern equipment which adds to the safety and pleasure of flying. Despite the fact that the "Seabee" is of complex amphibious design it will sell for $4000.

Invisible Rays

THE uncanny ability of invisible rays to take the place of chemicals in compounding processes is an inexpensive short-cut having far-reaching industrial possibilities. Invisible ultraviolet light from irradiation by electric lamps can furnish foods with hydrogen, a process called hydrogenation, can polymerize chemicals into dense, gummy substances such as plastics and rubber by uniting the molecules, and can make possible many new chemical compounds by invisible chlorination, a process commonly associated with water purification, Already ultraviolet radiations have been employed to improve the taste and odor of cacao oil and to vulcanize rubber.

Tests show that a well equipped instrument panel as in the Republic "Seabee" means added safety and enjoyment.

The photochemistry which abounds in nature is the most extensive chemical action in the world. Plants absorb the radiant energy of the sun, both visible and invisible, and through that energy create the matter of which plants are made. Radiant energy is so plentiful that that produced by the sun in a 12 mile square of West Virginia at noon on a clear day in June is equal to the energy of 100 Niagara Falls.

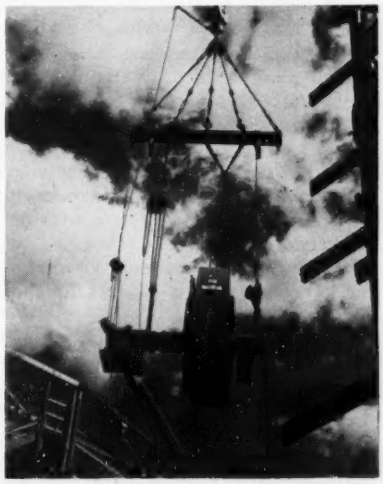
Illustrating the possible role of light in the explosives industry, Mr. Beggs irradiated a beaker containing toluene and chlorine in solution, used in the manufacture of TNT, with rays from an ultraviolet lamp. When the ultraviolet light was filtered out, only a thin, colorless layer formed on the top of the yellow solution. Next, the filtering device was removed, and the entire solution turned crystal clear after one minute's exposure to the ultraviolet rays. This was visible evidence that chlorination, the first step in many chemical processes in industry, had been accomplished primarily by ultraviolet light.

Crack Detector

IN a recent release General Electric has announced the development of a photoelectric crack detector that inspects glass jars and bottles as they pass on a rotary turn-table, automatically singling out and rejecting those with minute cracks or surface irregularities. These flaws, if allowed to pass, might prevent airtight sealing.

Inspecting the bottles as fast as they are made, this crack detector is much more rapid and accurate than a human inspector. The detector was developed especially for use in food packaging plants in order to cut down food spoilage. In one such plant it was previously found that, on the average, two out of every 100 glass containers with flaws escaped detection by human inspectors.

The containers automatically move in front of a sensitive photoelectric tube, are whirled rapidly



—Courtesy Westinghouse
"Package" Power Plant

as a strong light is directed on the part to be inspected, and then are rejected without interrupting the continuous bottle making process. The detector's phototube is not affected by a steady light, but the light reflected by a rapidly spinning bottle with even the slightest imperfection on the sealing edge causes the light beam to flicker. This quick change in the intensity of the beam is sufficient to eject the imperfect container while the perfect ones are allowed to continue on their way.

Cornell Society of Engineers

107 EAST 48TH STREET 1944—1945 NEW YORK 17, N. Y.

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540 Shoemaker Rd., Elkins Park, Pa.

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253 Forest Ave., Glen Ridge, N. J.

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

President's Message

THE passing of time will bring reality to the planning resulting from Tehran, Yalta, Bretton Woods and San Francisco. Economic overhauling and reconstruction for the entire world will be the big and continuing order of the day. And as always has happened in the past, world politicians motivated by selfish interests may force their issues to adoption and in the meanwhile sink the comparatively feeble attempts of altruistic groups for an enduring and happy peace. Whether the conferences bear good fruit, time alone will tell, but these conferences do bear a distinct significance to the engineering profession because the economic dollar is scheduled to play an important part in its meditations. I wonder whether engineers really consider how important the economic dollar is in their every day life. The mighty forces of organized labor have blazed the way and brought monetary gains to their groups, while the important and essential group of engineers and scientists, apparently too engrossed as always in their work, have not turned to problems pertaining to the promotion of their own welfare. Where would our economic wealth and labor be today if it were not for the ingenuity of the engineering professions? Where are the gains comparable with those of labor—that are long overdue the engineers? Certainly the engineer's dollar cannot buy any more or less than labor's dollar, but have we stopped to think of how much more the engineer has contributed to the welfare of humanity than has labor on the basis of the economic dollar? Certainly when the engineer barters the results of his productivity with that of labor, he finds the exchange a bad bargain. Labor produces the products designed and planned by engineers, of materials selected by engineers, and with production methods devised by engineers, all together bringing happier circumstances to labor,—meanwhile the engineer has received no comparable increase in benefits from the result of his application. In many cases large corporations require engineers to dedicate such patents as they may develop to their employers, thus closing off the only source for added income resulting from their ingenuity.

It is high time that the disparity of the engineer's economic dollar with that of labor's be overhauled. It isn't because labor's gains are begrudged, but more in keeping with the value of the respective services, certain adjustments and corrections are mandated. The comparatively small reward paid to engineers make him a philanthropist, and since science and philanthropy have no joint board of directors, he must work and solve his problems alone. His is an honorable estate to be sure, but like most honorable positions, the obligations are high and the return small. Because things have been that way, must they continue? How about getting on more even terms; how about getting a fairer exchange, leading to a far better livelihood commensurate, of course, with the results of his ingenuity and contributions to the common good? The problem is real, it belongs to the engineer; if he doesn't solve it, no one else will do it for him. This is no argument for collective bargaining, but certainly the engineer needs and deserves the overhauling of his economic dollar so that the returns are more commensurate with his contribution. Where would the world, society, achievement and labor be today if it were not for the engineer? Certainly, the engineering profession should not any longer ignore this problem; the solution is theirs and theirs alone. They shouldn't overlook the money and time spent on their education, and certainly their families are entitled to just a little more sunshine, a little more happiness than has been their lot heretofore.

This is my last message as the president of the Society. To my associates and committee members, and as expressed in my annual letter, may I repeat my appreciation of their splendid cooperation and enthusiasm during the past year. Through their contributions, your Society has grown in stature, in service, and in membership, and I am confident that under the newly elected leadership, it will continue to grow and serve the best interests of Cornell and its engineers. To me it has been a pleasant and beneficial association and the honor accorded me is one of the happiest which I shall long remember.

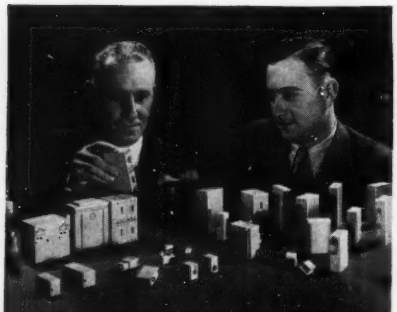
BERNARD A. SAVAGE, M.E. '25

TEACHER

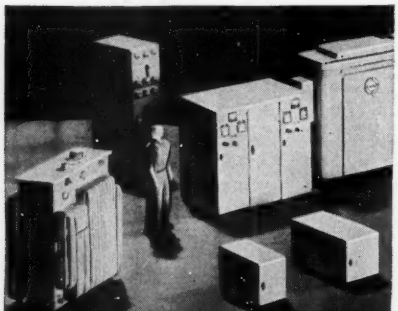
These sketches were made by Martin M. Newman, V-12, as he took notes in class. Reading from left to right and top to bottom: Prof. J. R. Moynihan, Prof. M. Bogema, Prof. B. J. Conta, Prof. W. L. Koch, Prof. J. O. Jeffrey, Prof. R. E. Clark, Prof. W. C. Andrae, Prof. M. S. Priest, and Prof. F. O. Ellenwood.

"DESK-TOP" PLANT LAYOUTS

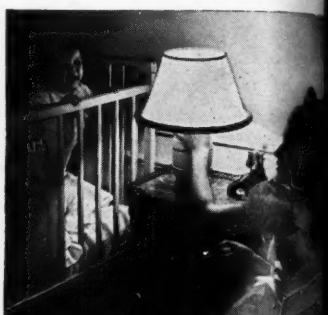
HOW THEY HELP SOLVE SUBSTATION PROBLEMS VISUALLY—SA TIME, PAPER WORK! TYPICAL OF A-C'S AID TO INDUSTRY!



1 Allis-Chalmers' new "Unit Sub Builder" set simplifies one of the most complicated jobs that industrial engineers face—modernization of power distribution for better economy and efficiency.

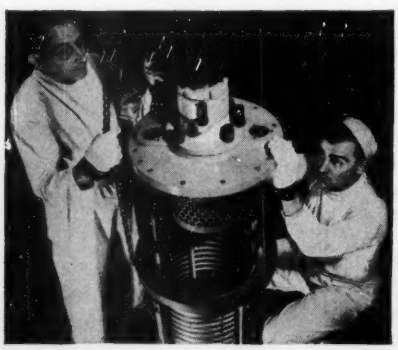


2 With accurate scale models of A-C unit substation apparatus, engineers can see just what equipment they need—how it should be arranged—without bogging down in complex charts, tables and diagrams.

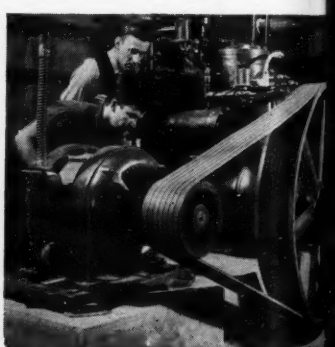


3 Uninterrupted and efficient p distribution to homes and pla vital and A-C's visual planning eliminate chance for error. Uni station planners can better me exacting needs of war produ

4 Helping produce super fuels for planes is the job of A-C Gas Turbines—another Allis-Chalmers' aid to industry. Today, A-C has more industrial gas turbines in use than all other companies combined.

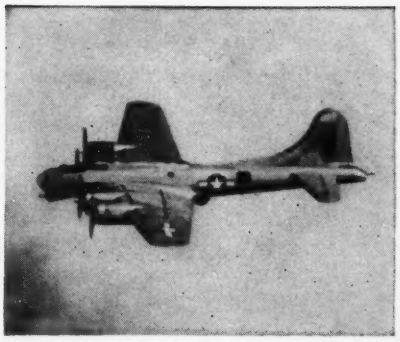


5 Developed and introduced by Allis-Chalmers, single anode Excitron rectifiers provide simple, reliable conversion from a-c to d-c power for industrial applications—250 volts and up.



6 Still another basic A-C de ment is the Texrope Drive. Th out industry, this Multiple V Drive, invented by A-C, tra mechanical power that give its clothing, food, 1001 nece

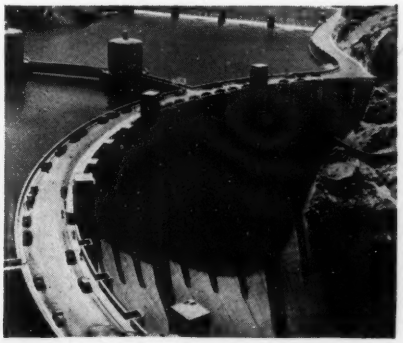
Even airports and highways are built with the aid of Allis-Chalmers. A-C supplies U.S.A.'s largest line of rock-crushing and milling machinery ... tractors, graders and bulldozers for all types of construction.



8 The ability of Allis-Chalmers to solve almost any kind of industrial problem was demonstrated two years ago when turbo-superchargers were urgently needed by the U. S. Army for bombers and fighters.

9 Not only did Allis-Chalmers build a complete new supercharger plant in record time, but quickly trained hundreds of inexperienced workers to mass-produce these highly specialized precision machines.

A-C engineering reaches into every industry. If you are a shipbuilder, A-C can supply you with steam turbines, pumps, motors, condensers, many other types of marine equipment.



11 At Boulder Dam, Niagara and Grand Coulee, A-C hydraulic turbines generate power for factories, homes, farms. Call on A-C's vast experience for help with *your* production problems!

12 Meet Mr. Bernard Pagels, one of many thousands of skilled craftsmen who insure the integrity and precision workmanship of Allis-Chalmers' products—over 1600 for U. S. Industry!

Allis-Chalmers Manufacturing Co., Milwaukee 1, Wis.

XPERIENCE PAYS BIG! Today, with Industrial

ckground and Skill more vital than ever, it's important to know

e Company with the widest range of Engineering Experience...

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PRODUCER OF THE WORLD'S LARGEST
INE OF MAJOR INDUSTRIAL EQUIPMENT

A-C

Tune in the BOSTON SYMPHONY
Every Saturday over the
Blue Network Coast-to-Coast
8:30 P.M. E.W.T.

College News

(Continued from page 20)

selaer Hall for which Prof. A. A. Allen, noted ornithologist, was the speaker.

At the April meeting, Prof. J. N. Goodier of the Mechanics Dept. was elected secretary with a slate of other officers, and a $500 Cornell Sigma Xi Fellowship fund was set up from the excess of the affiliation project, to be awarded when this sum is available.

Rod and Bob

ROD and Bob, Civil Engineers' social fraternity, announced the following new members for this term:

Tom Kiley
Gil Holmberg
Dick Jones
Bob McCaren
John Smith
Tom Fellows
Don Smith

The initiates attended a picinc and party in their honor the Saturday night following their initiation.

Pyramid

TOPPING off a very successful term, the Pyramid Society, Civil Engineering social organization, is sponsoring a dance Saturday evening, June 9, in the Memorial room of Willard Straight Hall. After building its membership from three to the limit of twenty-five, the club has engaged in several successful activities, including the ice-cream booth at the Spring Day Carnival, and initiation banquets for the twenty-three members inducted this past year.

The following men were initiated:

Chuck White
Brendon O'Hara
Gordon Richardson
Nick Eddy
Frank D'Alba
George Gates

ASCE

THREE illustrated lectures on topics of interest to Civil Engineer students, but attracting a large crowd from out of school also, highlighted the activities of the Student Chapter of the American Society of Civil Engineers during these past two months.

On Thursday, March 8, Mr. J. C. Pearson of the Lehigh Portland Cement Company spoke on "The Properties and Uses of Air-Entraining Cement." Mr. E. F. Rohwedder, U. S. Engineer Office, lectured on "Airfield Foundations and Pavements" on March 29, while on April 19, Mr. A. C. W. Sieke, of Merrit, Chapman and Scott, told of the salvaging of the Normandie.

Mr. Rohwedder

Alumni News

(Continued from page 21)

he has been teaching mechanical engineering (applied mechanics) at the Faculte Polytechnique de Mons. During the German occupation he took an active part in the underground movements of armed resistance against the enemy. His greatest joy was being liberated by the American Army on Sept. 3 and he is now doing his best to help the work of officers of this country.

WILBERT S. COOPER, M.E. '24, *has joined the E. I. duPont Co. as power engineer at the dye works. While here at Cornell he was associated with Ackart, Van Ness, McBertz and Evans, all Cornell graduates.*

DR. WILLIAM F. DURAND, Professor Emeritus of Stanford University, was reappointed Nov. 30 by the late President Roosevelt for a 5 year term on the National Advisory Committee for Aeronautics. Since 1941 he has worked in Washington, D. C., on jet-propulsion aircraft for military use. He was professor of marine engineering at the University for 12 years and Director of Sibley College before going to Stanford in 1904.

Henry Gieseler

(Continued from page 18)

decided in which branch of engineering he was most interested, Hank enrolled in the School of Mechanical Engineering, with the possibility of changing to some other school at the end of his freshman year.

During his first term, Hank pledged Alpha Tau Omega fraternity, of which he is now president. Later that term, he enrolled in the Navy V-1 program and in July 1943 was transferred to V-12 and returned to Cornell to continue his education.

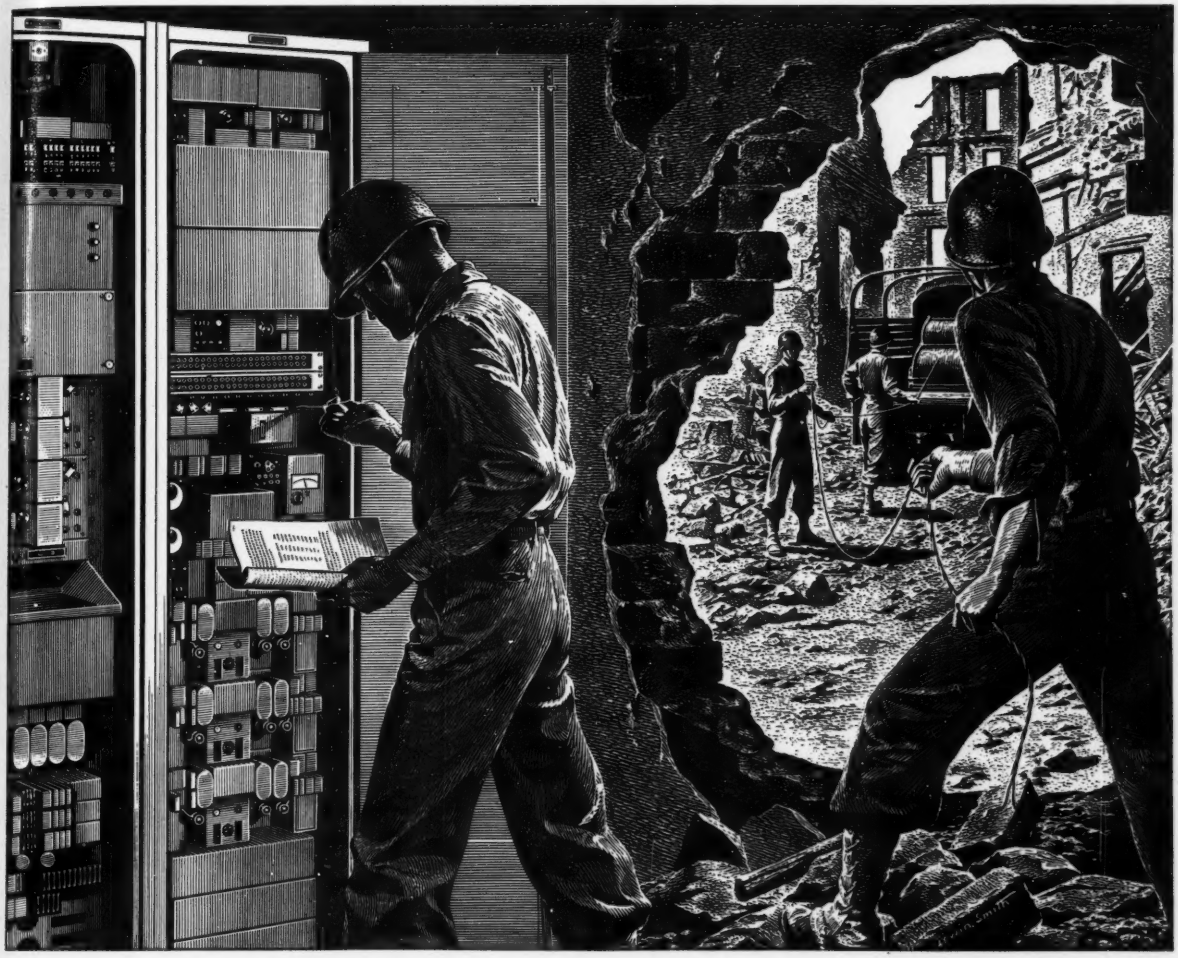
Back in his old stamping grounds, he took up college life where he had left it one month before. Toward the end of his fourth term he became a crew compet and was elected Assistant Manager in June, 1944. He is also a member of the Crew Club, A.S.M.E., and the Newman Club. These extra-curricular activities by no means interfered with his academic work and he was placed on the Dean's List his fifth term. During the following term he was elected to Tau Beta Pi and Atmos.

After strictly following the prescribed course of study for several terms, Guzzle decided to broaden his knowledge in fields other than heat power and mechanics. One of his more interesting courses this term is the Home Ec, "Love and Marriage" course where he is known as Miss Gieseler. When questioned about one of his other subjects he stated, "Naval Organization is a wonderful course and I'm really thrilled at the opportunity to learn so much valuable information about our Navy; besides, they caught up with me and I have to take it!"

Upon graduation in June he expects to go to midshipman's school and then into some active branch of the Navy. When the war is finally at an end and Happy Hank can don "civies" again he hopes to return to Cornell to round out his education and enjoy a little more of the "old Cornell party life."

Electrical Weapons by the Maker of Bell Telephones

No. 3 of a series: *for the Signal Corps*



How to make 2 wires do the war work of 20

As our armies push forward, they need more and more communications channels. They get them *quickly*—thanks to Western Electric carrier telephone equipment.

Without carrier, 2 wires ordinarily carry one telephone and one or two telegraph circuits. By using *carrier* equipment, more telephone and telegraph circuits can be provided without adding more wire. This makes maximum use of existing wires—eliminates the need to manufacture, transport and install thousands of additional miles of wire—saves countless hours in providing vital circuits.

The Army, for example, uses carrier to obtain three telephone and fourteen telegraph circuits over one pair of wires. Even with the use of much carrier equipment, the Army's consumption of wire in France ran as high as 3,000 miles per day.

Carrier telephone equipment has long been made by Western Electric for the Bell System. Army needs, however, differ in many ways from regular telephone requirements.

To meet these wartime conditions, Bell Laboratories engineers designed a revolutionary "packaged" carrier equipment for the Signal Corps. Self-contained, completely wired for quick, easy installation, these units have been produced by Western Electric in vast quantities. On every front, they are speeding our Circuits for Victory!

During the Seventh War Loan Drive, buy bigger extra War Bonds!

Western Electric

IN PEACE...SOURCE OF SUPPLY FOR THE BELL SYSTEM.
IN WAR...ARSENAL OF COMMUNICATIONS EQUIPMENT.

Gadgets

(Continued from page 15)

out to within ± 0.01 grams, and are transferred, in small portions, to the tube. After each addition, the tube is tapped repeatedly to insure packing. When the entire sample has been transferred, any material that has sifted through onto the glazed paper is put into the tube, the paper is replaced, and the tube is again tapped for one minute. Any final siftings are put into the tube but the tube is not again tapped. The distance from the top of the tube to the top of the sand column is measured.

The cap is screwed firmly on the top of the sample tube—taking care to hold the tube vertically while this is done—and the sample tube is clamped in position on the frame and connected with the air lines. Air is drawn through the sample and through one of the standard disks at a constant rate, as indicated by the manometer across the disk. The disk selected for comparison should be the one that gives a differential pressure nearest that across the sample. The rate of flow is kept constant until both manometers remain constant; then both manometer readings are noted.

Measurements are made least at three rates of flow, and the readings on the manometer across the disk are plotted against the readings on the manometer across the sample. If the points do not define a straight line, at least two more measurements are made.

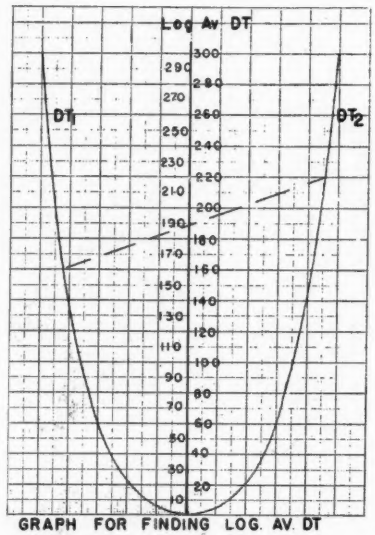
In no case should the rate of flow of air be above that at which, for the disk used, the relationship between flow rate and pressure drop ceases to be linear. No readings should be taken until, at the flow rate chosen, the differential pressures across the sample and across the plate become constant.

Mathematical Development

Space does not permit the detailed development here of the equation that expresses specific surface in terms of the weight of the sample, the dimensions of the column of sample in the tube, and the density of the solid. This general equation is given in the book on "Micromeritics", by J. M. Dalla Valle (1943), page 266 and following. For ground silica, using a 10-gram sample, in this specific sample tube, the equation reduces to:

$$A = 62.7\ [(1 - 5.36/(20.3 - D))^3 (20.3 - D)]^{0.5} \times (1/h)^{0.5} \times (1/k)^{0.5}$$

where



GRAPH FOR FINDING LOG. AV. DT

This nomograph has been found very useful for estimating the logarithmic mean between two terminal values. The graph is of particular importance in heat transfer problems.

A=specific surface, cubic cm. per gm.

D=distance from top of cylindrical section of sample tube to top of sample, cm

l=differential pressure across column of sample, cm water

h=differential pressure across standard resistance plate, cm water

k=correlation constant for standard resistance plate

From the specific surface as measured, the mean diameter may be estimated from the equation where

$$A \times S = K \times d \times d$$

A=specific surface, square cm. per gm.

S=density of solid, gm. per cubic cm.

K="shape factor"

d=average particle diameter, cm.

For any specific material, K can be found from measurements of specific surface of sized fractions whose diameters are measured by some independent means. When the shape factor has once been established for any specific powder, the permeability method permits estimation of the mean particle diameter of a powder of sub-sieve fineness or of an un-sized powder. In unsized material—as, for example, the -200-mesh fraction of ground sand—the diameter thus found is the "average particle size with respect to surface," a, where

a=summation of n times d cubed divided by summation of n times d squared.

n=number of particles of each specific diameter,

d=diameters of individual particles.

Acknowledgement

The material for this article was taken from the Chemical Engineering laboratory notes compiled by Prof. F. H. Rhodes, Director of the School of Chemical Engineering, Cornell University.

Prof. F. H. Rhodes

(Continued from page 7)

port my contention that most cases of poor teaching are caused by failure to realize that the teaching is poor, and can be remedied if the instructor is made aware of his shortcomings and will apply, in the perfecting of his teaching methods, the same intelligent study and critical analysis that he uses in improving himself in his technical field.

I agree with the suggestion that the considered opinion of the students in a class is a valuable criterion of the ability of the teacher. It may be more valid than the estimate of a department head.

I disagree with the suggestion that "unpopularity contests" be held from time to time. Formal criticism of a teacher should be made only after serious consideration, and should involve no element of mere personal dislike or of lack of interest in the subject matter of the course.

In the School of Chemical Engineering, we have sometimes requested each old student to express, in writing, his comments on any courses in his previous curriculum that were unusually well taught or unusually poorly taught, and to state the reasons for his opinions. These signed written statements were submitted directly to the director of the school, with the specific understanding that in no case would the name of the writer be revealed.

These criticisms were evaluated

(Continued on page 52)

Nothing Rolls Like a Ball . . .

. . . but Mrs. J. Woofington Smith-Smythe wishes she hadn't had to demonstrate it in just that way. Especially since that fundamental fact *is* being demonstrated in *thousands* of ways in every phase of war and industry.

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Russia

(Continued from page 9)

crane runway girders and the like up to ten tons and more in weight, were prefabricated in special heated shops near the site, transported to the building, and erected irrespective of weather conditions. Ends of reinforcement, protruding from the prefabricated members, were welded in place to the reinforcement of adjoining members to insure continuity, and joints then cast with preheated, quick-setting cement.

Failure

Another experiment, carried out on a very large scale, failed completely. Someone had figured out that one could cast concrete at any temperature, let it freeze in the forms and let the formwork stand until spring. Then, supposedly, the concrete would thaw out and set and harden as if nothing had happened. This procedure, without sufficient advance investigation, was actually carried out on many structures with the result that the concrete, although it actually did harden, showed such low strength that the structures had to be razed and rebuilt.

Regular reinforced concrete plant frame supporting timber roof trusses. Copper refining plant, Krassnouralsk, U.S.S.R.

A different procedure was much more successful: a Swedish engineer had done some research on electrical resistance heating of concrete without ever using it commercially because of the high power cost. Cost was no question in Russia; all that mattered was that the structures had to be built. So this method was used extensively. In its simplest form the reinforcement, or some special rods inserted in the wet, preheated concrete, served as one electrode, while forms lined with thin iron sheets served as the other. The current passed through the wet concrete, developing heat due to the resistance, and kept the concrete from freezing until it had hardened sufficiently so that little, if any, free water was left.

During the last four years of my stay I did some part-time college teaching in my spare time. Colleges were organized much along American lines, with all students being housed in dormitories and subject to rather strict discipline, not only during class hours. At that time no tuition was charged; on the contrary, all students held State scholarships, varying according to their achievements, which were sufficient to pay for living expenses on a subsistence level. This procedure

(Continued on page 36)

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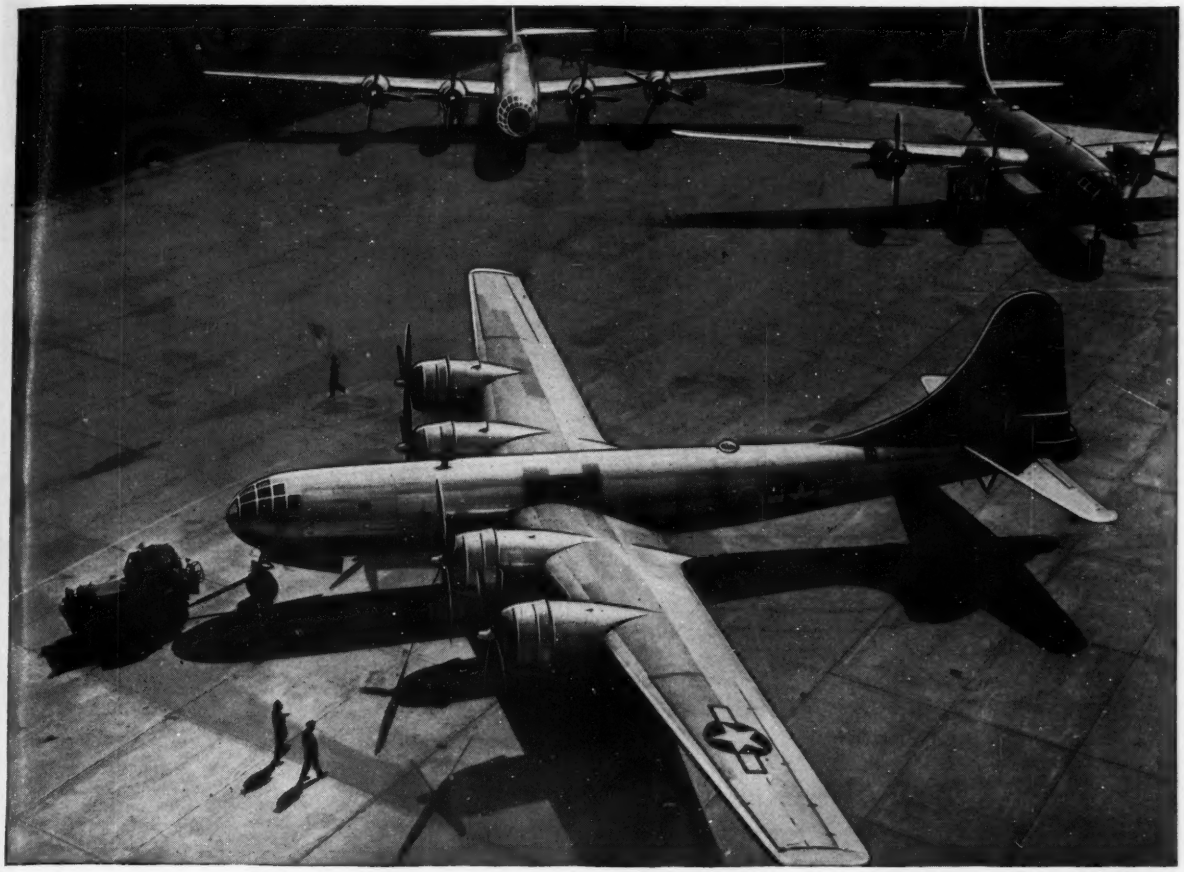

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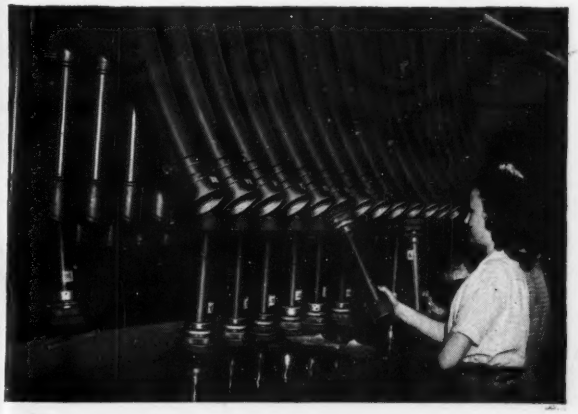

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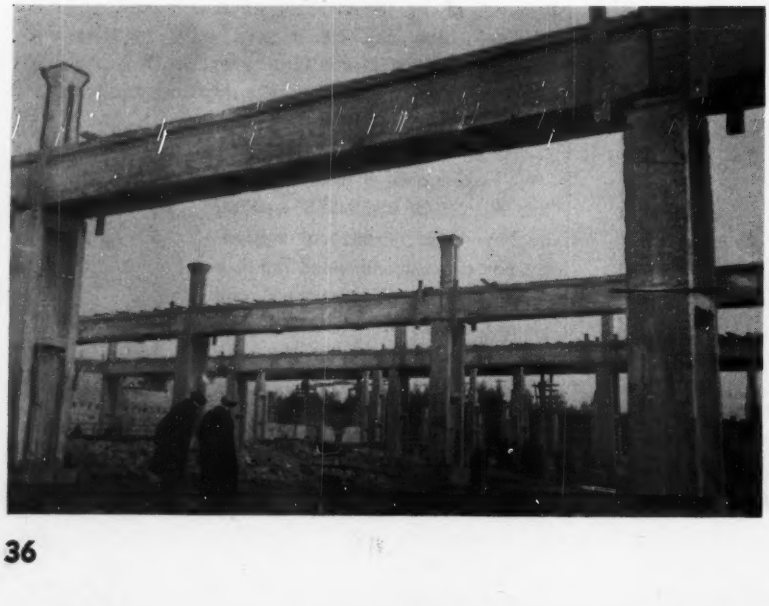
"WHERE SERVICE IS A HABIT"

Russia

(Continued from page 34)

was abandoned a few years ago, and a rather considerable tuition is now being charged, with scholarships available only in exceptional cases. This, it seems to me, was a rather fundamental change in policy. Whereas formerly students used to come from all walks of life irrespective of parental income, the new set-up inevitably tends to perpetuate the present ruling officialdom since only people with the relatively large income of managers, engineers, or highly skilled workers will be able to send their children to college. Whether this measure is temporary remains to be seen. A very large percentage of engineering students were women, running in some of my classes up to 50% or more. At the expense of male self-esteem I have to admit that I could hardly, if at all, notice any difference in the scholastic achievements of the two sexes. Quality of teaching was rather varied, much of it being done by part-time staffs otherwise engaged in industrial work. Instruction was mostly limited to the theoretical side; laboratory equipment in the colleges of that particular locality was extremely scanty or non-existent.

Heavy, precast reinforced concrete columns with crane runway girders installed. Sverdlovsc, U.S.S.R.



Before closing, it may be of interest to cite one example of the amazing foresight of the Russian government in regard to foreign policy, as far as industrial planning was concerned. Most of the plants we designed were built under extreme pressure, much of the equipment often being installed even before the structures were completed and the roof was closed. However, at one time around 1935 or 1936 we were asked to design what we later came to call the 'ghost-factories." They just consisted of huge halls of clear floor-space, no lay-out of machinery being given to the designer

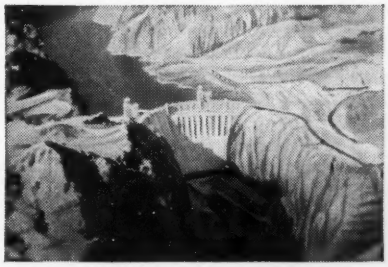
(Continued on page 40)

COMING YOUR WAY

A New Kind of Horsepower is Changing Your World

This is the story of what is likely the biggest thing that has happened in our time . . . of a new kind of power spreading throughout the world . . . of a new force affecting our lives, our outlooks, and our incomes as perhaps only electricity has done since the turn of the century.

1. Under the wing of a giant Lockheed Constellation, in the shadow of one of the big ship's four Wright Cyclones, two men talk. One is a veteran airline pilot who lives and works in a world most people haven't yet begun to know or understand or even to imagine! The other, a man who has seen a whole vast western section of America change in his lifetime as if by magic!



2. The Westerner operates a ranch that was literally made possible by power — electricity and irrigation from the great Boulder Dam harnessing the Colorado River. Power which made possible the conversion of millions of acres of barren wilderness into fertile ranches and farms!

3. No wonder he's eager to hear the pilot tell of a new super-power — such as that of the Wright Cyclone . . . the engine which speeds the great Boeing B-29 Superfortress across the air miles to Tokyo . . . power that makes possible a trans-Atlantic flight every 13 minutes.

4. Most efficient power plant in the world, today's Wright Cyclone packs a horsepower into less than a pound of metal. Four Cyclones develop more power than the mightiest locomotive operating in the Rocky Mountains . . . and already this new power is changing ranches and farms, business and homes . . .

5. These Cyclones help make possible the operation of U. S. transport planes over more than 110,000 miles of global air routes. For example, 1,800 cargo shipments daily leave a single U. S. airport, and millions of miles are daily flown by U. S. airlines and the Air Commands of our armed services.

6. Carrying our men, materials, ideals to the corners of the earth — breaking down barriers of distance — the Cyclone power of American aviation is changing the world you live in...right over your head!

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Aluminum

(Continued from page 11)

would mean a large net saving to the city because the cost of the new floor was much less than the cost of 25 years of depreciation and interest on a new bridge.

Similar reconstruction of the Brooklyn Bridge was proposed in 1935, but has not been carried through. All lift bridges and most long-span bridges are expected to provide a large market for aluminum after the war, according to Mr. Stanley V. Malcuit of the Aluminum Company of America.

Conservatory

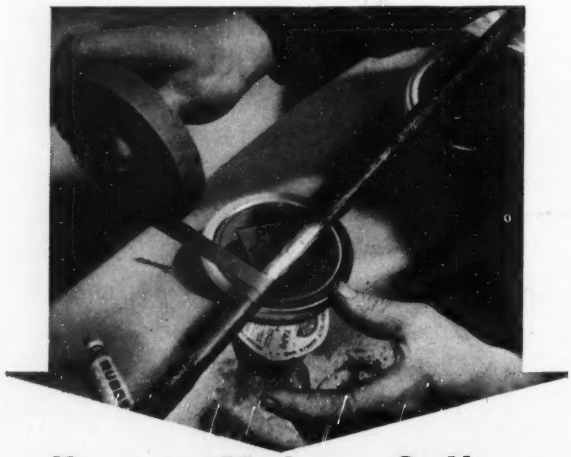
Aluminum cantilever roof trusses, forming the dome, and a combination of aluminum and steel for the structural framing, are special features of the conservatory built for the United States Botanic Garden in Washington in 1932. Structurally, the design follows the conventional form of such buildings, with arched and domed roof-framing carrying a great expanse of glass sheeting. This is the first large building in which aluminum was employed to any great extent, using 33 tons of alloy, along with 276 tons of steel in the 284 x 183 x 85 feet high, hollow, rectangular building. In this case, aluminum was adopted mainly to reduce the cost of maintenance, cleaning, and painting, especially in the lofty portions that are difficult to reach and which are subject to hot, moist atmospheric conditions favorable to the corrosion of steel. The columns are of steel, but the cantilevers, trusses, purlins, and bays are of aluminum. The channels, which constitute the principle shape, range from 3-inch 1.45-pound to 8-inch 4.08-pound, assembled with aluminum rivets driven hot. The dead load of aluminum and glass was taken as 4 pounds per square foot, supporting a normal snow load of 25 pounds per square foot. Aluminum was also used for architectural details, such as glazing bars, grilles, doors, and other interior fittings.

In fabrication, aluminum required sawing because shearing would not give clean cuts; punching was easier, and handling was greatly simplified. Riveting offered the chief problem; it finally was decided to drive the rivets by compression at a carefully controlled temperature, hand riveting being considered impossible.

Today, aluminum is being used not only for machinery in manufacturing plants but also for earth-moving equipment in building the plants.

In erecting structures, aluminum is valuable for excavation. Aluminum booms have 15 to 20 per cent greater reach, while buckets have a fourth again as much capacity with no effect on mobility or stability of the excavator as compared to all-steel design. Cranes, weighing 25 to 60 per cent less, and which are much more weather resistant, provide the contractor with a few less problems.

Steel is firmly entrenched in the building of static structures. Even if aluminum or other light metals and alloys were as inexpensive as steel, they could not replace in the future that metal in many of its uses. Yet they will share more and more of the field of structures with steel, not only enhancing the usefulness of the structure itself, but also complementing and increasing the value of the steel.



How to Make a Splice in Rubber Insulated Cable

● Illustrated Bulletin OK-1007 describes various splices and tapes for rubber insulated cables up to 5000 volts. To obtain a copy just write The Okonite Company, Passaic, New Jersey.

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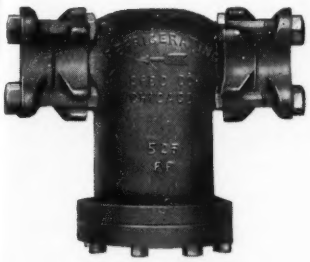

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For use with and control of following refrigerants:
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Orifice Sizes ¼" to 12"
Connections ¼" to 12"
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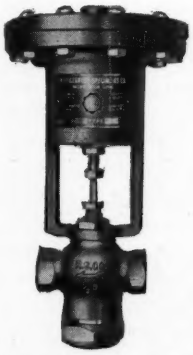

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- Automatic Pressure Unloader with Timing Relay
- Automatic Evaporator Pressure Regulator with Manual Seat Lift
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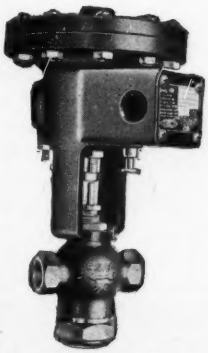
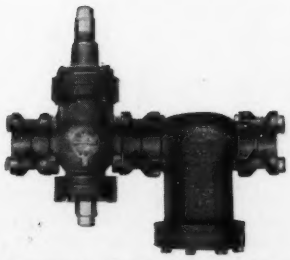
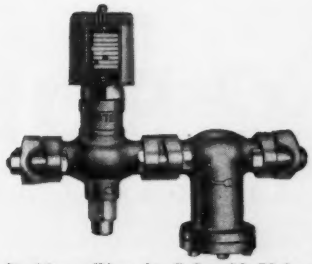


Automatic Condensing Water Regulator with High Pressure Electric Cutout.



Automatic Evaporator Pressure Regulator with Manual Seat Lift; with Strainer Trap.



Packless Electric Solenoid Valve with Manual Seat Lift; with Strainer Trap.

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AIRCORD, SWAGED TERMINALS AND ASSEMBLIES • AERIAL WIRE ROPE SYSTEMS • ROUND AND SHAPED WIRE • ELECTRICAL WIRES AND CABLES • WIRE CLOTH AND NETTING

Russia

(Continued from page 36)

for guidance, except required overall clearances. These ghost-factories were built and there they stood, all complete and all empty. They were still empty when I left in 1938.

What we did not know at the time was that the government, half a decade in advance, prepared for war and that these ghost-factories were part of that preparation. Much of Russia's new industry and all of her old industry is located in the western parts, those that were subsequently over-run by the Germans. As early as the second half of the thirties, the Russians started to provide for the eastward evacuation of such vital factories as were movable at all. And that was what these empty halls were there for. They were supposed to receive the machinery equipment of western plants if and when the necessity arose for evacuation. From such scanty accounts as have come from the Urals during recent years from reporters and other travellers, I am practically sure that these ghost-factories, equipped from evacuated plants in regions temporarily over-run, are now in full production and are contributing very materially to the Russian armament industry.

Metallurgy

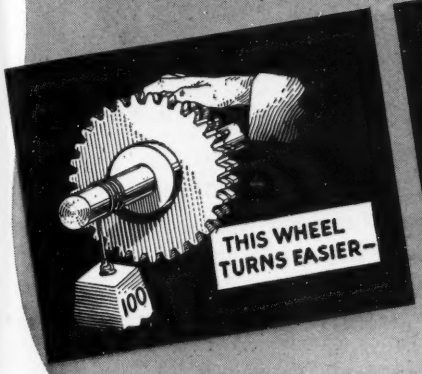
(*Continued from page* 13)

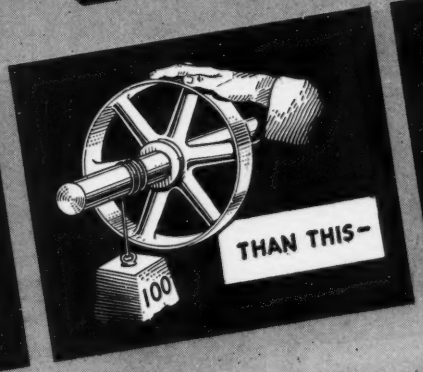
resistance, while tungsten protects the contact from damage at high temperatures. Another application of two-property alloys is found in brushes used on electric motors and generators. All such brushes were formerly molded from carbon powder, carbon being the only material which would prevent terrific pitting and wear on both commutator and brushes. Carbon, though, has a high resistance, and a material of low resistance is desirable in many applications. A brush which has this low resistance, yet retains the necessary surface characteristics, is made by molding a mixture of copper and carbon powders. The copper particles weld together during sintering and act as a bond for the carbon particles. Millions of these brushes are now made for generators and motors in warplanes, and

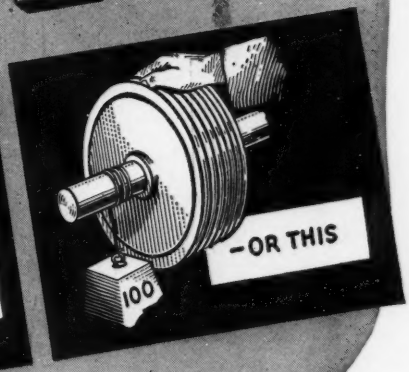
(Continued on page 42)

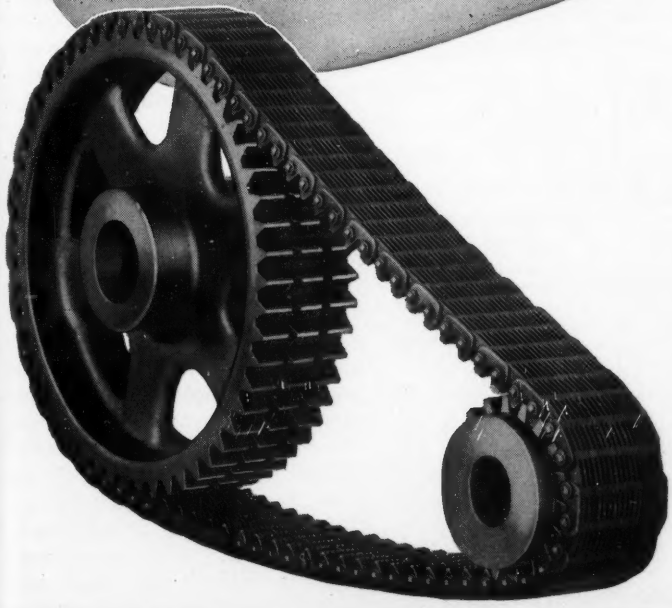
You can depend on

Teeth Not Tension









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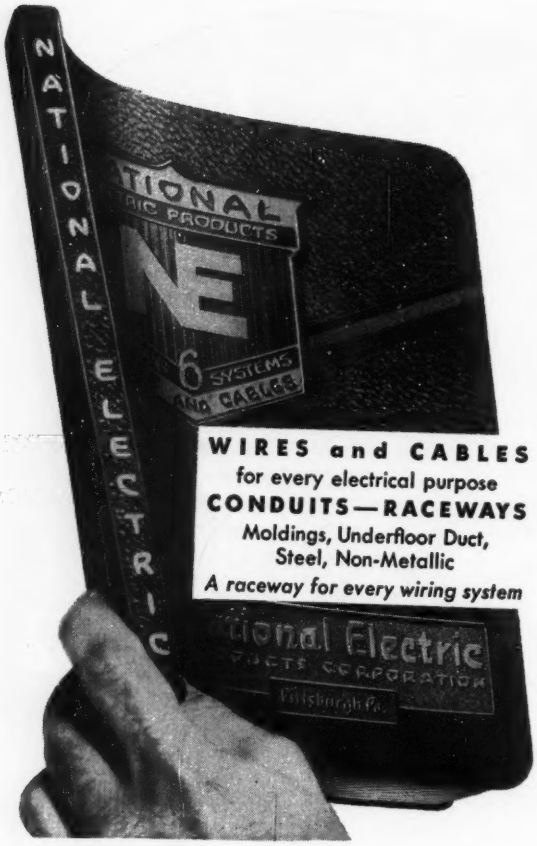

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For Your Listening Pleasure

"MURDER AFTER MIDNIGHT"
"REQUESTFULLY YOURS"
"A STUDENT & THE NEWS"
"THE MUSIC BOX"

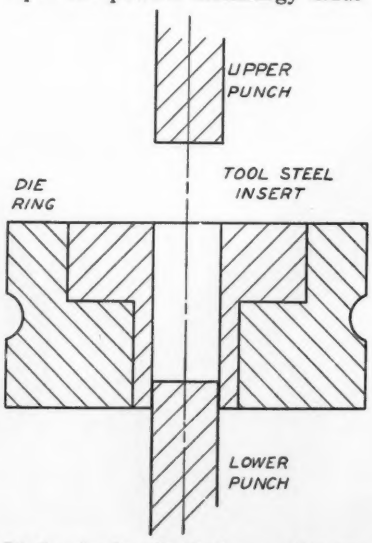
Metallurgy

(Continued from page 40)

will be used on automobiles, trucks, and planes after the war.

Powdered iron has been used for many years in the telephone industry for making induction coil cores. At audio frequency, eddy current losses prohibit the use of ordinary iron cores, but in the powdered core, iron particles are insulated from each other, thus offering such high internal resistance that eddy currents in the iron are negligible. This insulation is accomplished by adding a few per cent of resinous powder to the mix. The resin acts both as insulation and binder—iron cores are not sintered, but merely baked at a low temperature to set the binder. In recent years such iron cores have been widely adapted to radio use at frequencies as high as 175 megacycles per second. They were used before the war in tuning circuits of small low-cost commercial sets, replacing more expensive variable condensers. At present the Army is using huge numbers in fixed frequency "walkie-talkies" and aircraft sets.

The products mentioned so far illustrate those which have developed the powder metallurgy industry on a solid but limited basis from 1920 to 1940. All these products and others developed during this period were made from powder only because there was no other way of making them. Powder metallurgists were thus able to iron out their kinks without the additional worry of competition from another field.

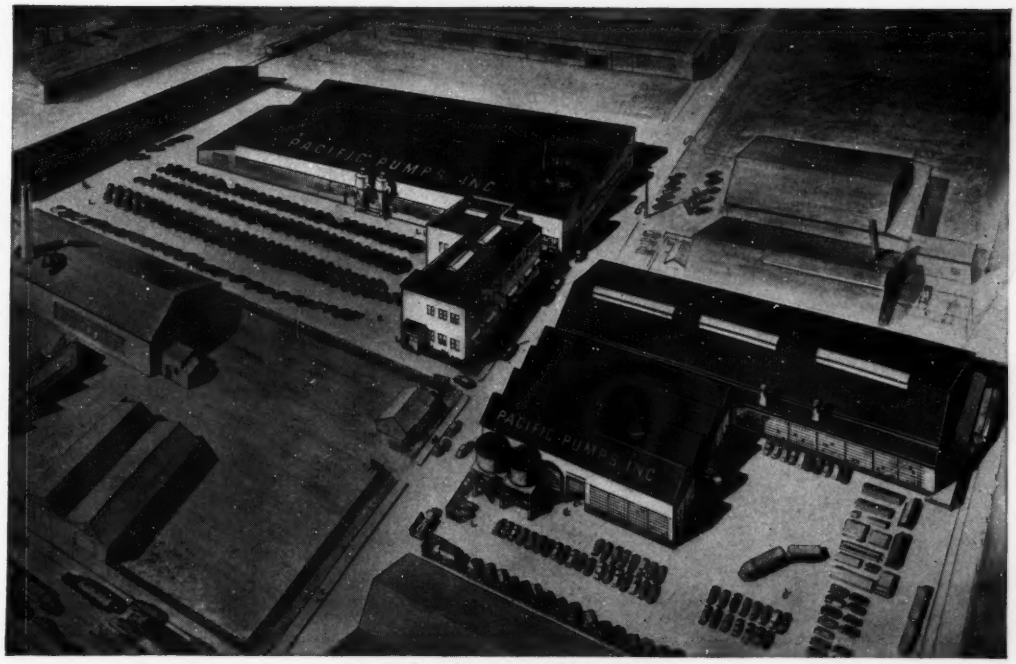


Die for simple cylindrical part. After die is filled, upper punch compresses powder to one third of its former volume. Lower punch then ejects molded part at top of die.

But about 1939 the infant industry suddenly began to grow by leaps and bounds. This development was in a completely new direction—that of making iron and steel parts in direct competion with die casting and machining. A great part of this work was done by automobile companies and the prime peacetime example was an oil pump gear used on many makes of cars. The pump consists of a tight housing over two meshed gears. As the gears rotate in the oil, they force it through the housing to the area to be lubricated. These gears were formerly hobbed from cast iron blanks in an operation which wasted 64 per cent of the original metal and took thirty man-hours of highly skilled labor for every thousand gears. The molded gears take only fifteen man-hours of semi-skilled labor per thousand gears;

(Continued on page 44)

"Achievements in the Field"



PRECISION ENGINEERING

In this completely modern plant, Pacific Pumps are designed and produced to meet all pumping requirements with the maximum of economy and efficiency. Pacific pioneered fine-dimension pumps, pumps whose life is measured in years rather than months, pumps into which have been incorporated all that is new in design, in methods and in material. Whether the liquids be light or heavy, the temperatures extremely high, or down to sub-zero levels, Pacific Pumps can be relied upon to meet all variations in pumping conditions. Available in an unsurpassed range of types and sizes, you'll find Pacific Pumps in refineries, in oil fields, and in industrial and municipal plants all over the world—where they are delivering the most of the best daily. This is why users everywhere are agreed that whatever the job, *"you can't buy better pumps than Pacific's."*

PACIFIC PUMPS, Inc.
HUNTINGTON PARK, CALIFORNIA

FOR CONTINUOUS OPERATION

Mr. H. W. Camp, Manager of the Refining Division of the Cities Service Oil Company writes of these Clarks in their East Chicago refinery:

"These compressors are a vital part of the alkylation unit and both must be in operation continuously to maintain the maximum rate of alklate production. This unit has one of the finest records in the industry for continuity of operation and rate and quality of production."

CLARK BROS. CO., Inc.
OLEAN, N. Y.
"TWO OF THE DRESSER INDUSTRIES"

Metallurgy

(Continued from page 42)

waste totals a fraction of one per cent; investment in machines is much less; the gears are considerably closer to a true involute shape; the surface is more wear resistant and smoother, reducing noise; and the material has strength equal to that of the cast iron gears. However, in 1941, when one large manufacturer used sintered oil pump gears on all his cars, the price of the iron powder used was sixty cents per pound, so high that the net saving on the molded gear over the cast was rather small. With the terrific expansion caused by the war, though, the price of similar iron is expected to fall to twenty cents or less per pound. One writer has proposed a method of producing powder from a low grade Minnesota ore at five cents.

War Speed-Up

While production of this gear and many other machine parts was well under way by 1940, the real growth was during the war. When the pressure was on during the shift to war production, everything made was new, and everything was wanted in a hurry. To get a machine shop setup producing took many weeks or months after specifications were drawn up. Industry soon discovered that powder metal manufacturers could make a die, put it in the press, and be in production in a few days or weeks after an order was received. On one triple A priority order, the first part came out of the sintering oven in forty-eight hours. So, to the plants which had gained experience making such specialties as porous bearings, carbon brushes, and iron cores, came rush orders to make iron parts for all branches of war industry. At the same time, our supply of high quality, low price Swedish sponge iron was cut off, and researchers who had been working for ten years had to put on that last ounce of steam to perfect satisfactory methods of powder production in this country. The use of metal powders reached six thousand tons in 1941, and is estimated to have doubled each year since. One of the automobile manufacturers has produced *six thousand* different parts during the war years. A typical example is a bronze gun sight bracket which skilled machinists formerly milled to shape in less than three hours, producing at the same time a large pile of valuable chips of copper and tin. Any high school boy can now turn out this part in twelve seconds with negligible waste to tolerance of a thousandth of an inch. Tolerances of half this amount have been produced by repressing the part after sintering.

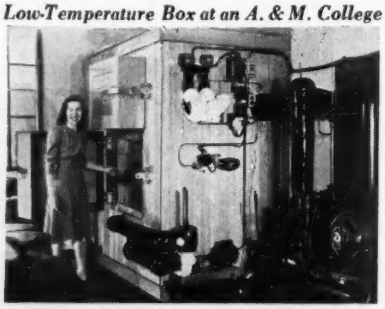
Alnico Magnet

Another powder product being made in large quantities is the Alnico magnet for use in electrical instruments, a great number of which go into every airplane and tank. Sintered Alnico is stronger, more uniform, and in small sizes, cheaper than the cast product. Other airplane parts include engine mount and gun turrent parts, carburetor shafts, cams, pulleys, instrument components, and propeller parts. It is very difficult to get information as to the parts made for military use, but it is hoped that those mentioned will serve to show the diversity of possibilities, especially when it is realized that the list is only an inkling of what is being done.

To summarize, it may be well to

(Continued on page 46)

Low-Temperature Box at an A. & M. College



For really COLD temperatures, look to

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Low-temperature refrigeration is being used more widely every day.

It's already indispensable for quick-freezing foods, drying blood plasma and penicillin, and testing engines, guns, radios, etc. under stratosphere conditions.

Also for super-hardening tool steels, aging gages and castings, shrinking tight-fitting parts, liquefying gasoline and natural gas, and for various kinds of research and process work.

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This company is experienced in railroad, airport, utility, highway and industrial construction.

INQUIRIES ARE INVITED

How **Gas** advances the science of heat treating

Gas-fired rod annealing furnace; photo courtesy of Selas Corporation of America

Research in Gas application, through the ceaseless study and experiment of equipment manufacturers, independent laboratories and the facilities of the American Gas Association, is constantly producing improvements and new departures in the application of heat, industrially.

For example, heat treating of metal rods in batch furnaces has certain disadvantages, particularly that of uneven heating throughout the bundle of rods. A group of engineers recently perfected a continuous-flow type Gas-fired furnace with a ceramic heating unit capable of intense, focussed heat, and closely fitted to the shape of the work in progress.

There are many advantages to this new Gas technique for annealing. For instance, one inch rod stock passing through a six foot furnace of the new type can be heated and quenched at a rate of 12 feet per minute, no section of the metal remaining under heat more than thirty seconds—against 2½ hours in a batch furnace. Furthermore, better uniformity of heating is achieved; scaling, distortion, decarburization are minimized. Floor space of the new furnace is 24 square feet against several hundred feet for the older type. Over-all costs are also considerably reduced.

Local Gas Companies help make these new benefits of Gas and Gas Equipment available to industry through the services of skilled Industrial Gas Engineers, who are available for consultation without obligation.

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HARRISBURG STEEL CORPORATION

Harrisburg, Pennsylvania

Metallurgy

(Continued from page 44)

list, in a general way, some of the reasons for the rapid growth of the powder metallurgy industry. These include:

a). Certain metals or mixtures can be worked, and certain properties achieved, only by powder metallurgy.

b). The method of manufacture is precise, simple, and cheap.

c). Powder is expected to become cheaper.

d.) Application of science instead of trial and error methods is just being made to problems of powder metallurgy, and may result in many unforseen developments. Laboratory work has already brought forth a powder alloy having a hardness of Rockwell 65C and a tensile strength of 140,000 pounds per square inch, comparable to high quality steel. Laboratory results from hot pressing experiments (that is, pressing and sintering simultaneously) promise exceptionally good results in the near future. This list has much more reality when viewed in the light of the statement of a Ford engineer who predicted that post-war Ford cars will have one hundred pounds of powder metal parts, as compared to a pre-war three pounds. A hundred pounds, while not a great part of a one and a half ton car, is certainly a very large per cent of the total weight of small metal parts in that car.

All this is not to say that powder metallurgy can be expected to do everything, or almost everything. Some of the major limitations are listed here:

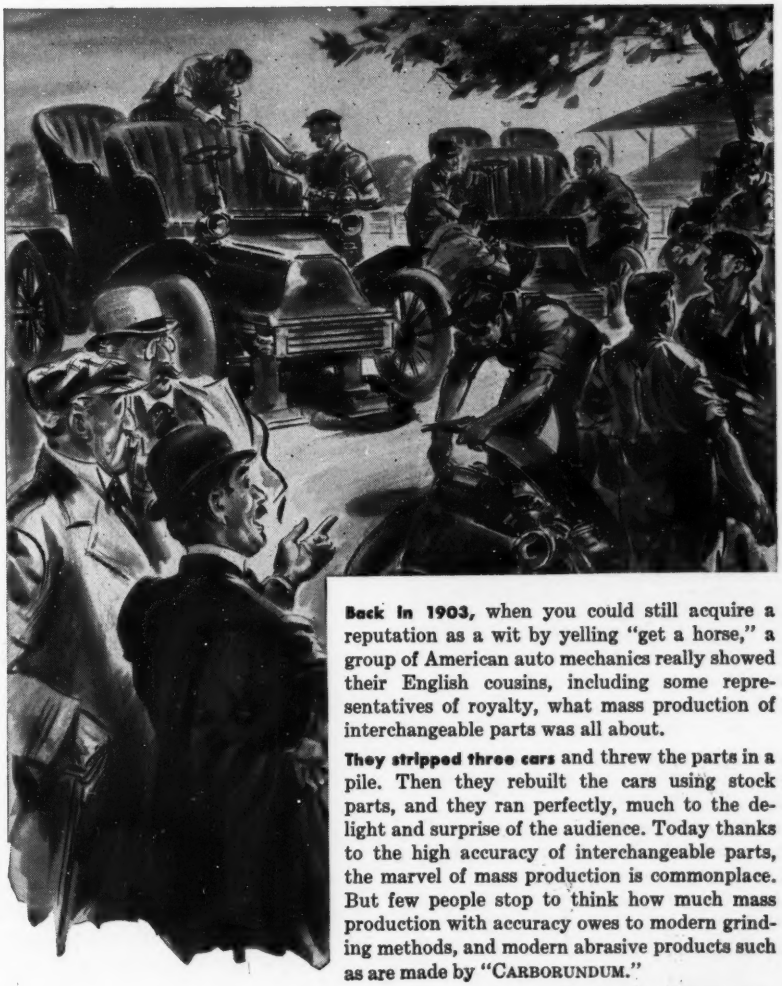
a.) Certain shapes are very difficult or impossible to make. These include threads, re-entrant angles, and sharp corners.

b.) There seems to be a definite limit to the economical size of molded parts.

c.) Economical production of parts having both excellent physical properties and close dimensions is a tough problem which may or may not be solved in the near future.

So, while nobody claims that steel rails will ever be made from iron powder, engineers familiar with powder metallurgy are united in enthusiasm about its bright future possibilities.

The grease monkeys that tickled Royalty!



Back in 1903, when you could still acquire a reputation as a wit by yelling "get a horse," a group of American auto mechanics really showed their English cousins, including some representatives of royalty, what mass production of interchangeable parts was all about.

They stripped three cars and threw the parts in a pile. Then they rebuilt the cars using stock parts, and they ran perfectly, much to the delight and surprise of the audience. Today thanks to the high accuracy of interchangeable parts, the marvel of mass production is commonplace. But few people stop to think how much mass production with accuracy owes to modern grinding methods, and modern abrasive products such as are made by "CARBORUNDUM."

Helping industry increase production and lower costs is one of the most satisfying of occupations. And that is the job of "CARBORUNDUM" Abrasive Engineers. If you would like to consider this form of engineering for your life work, please write The Carborundum Company, Niagara Falls, New York.

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Right and On Time Since 1909

Materials Lab

(Continued from page 17)

test. Someone who has written a materials report may be shocked at the words "all that remains" because sometimes report writing is a long and bloody job. At the start of the term, students are told that they should not have to spend any more than seven hours on one report, but most of them find that the instructors computations are off a bit and that the time is closer to ten or more hours. This may be due to difficulties which arise when a straight line curve does not come out straight, or to time lost when the student finds that last term's outline is not like this term's. It goes without saying that, although a week's time is alloted for writing up a report, most reports are written the night before they are due. After the report is dropped hesitantly in the instructor's box, all that remains is to pray it will not be returned for revision.

Students generally agree that the materials lab staff are among the most likeable instructors in the school. One reason for this may be that besides being experts in materials testing, they are also darned good bowlers, as proven by their performance in the Sibley bowling league.

After the war, students and instructors will have a much better working environment. First of the proposed new engineering buildings will be a Materials and Metallurgy Laboratory. This laboratory will have modern facilities for the treatment and testing of metals, fuels, lubricants, soils, concrete, bitumens, and other engineering substances.

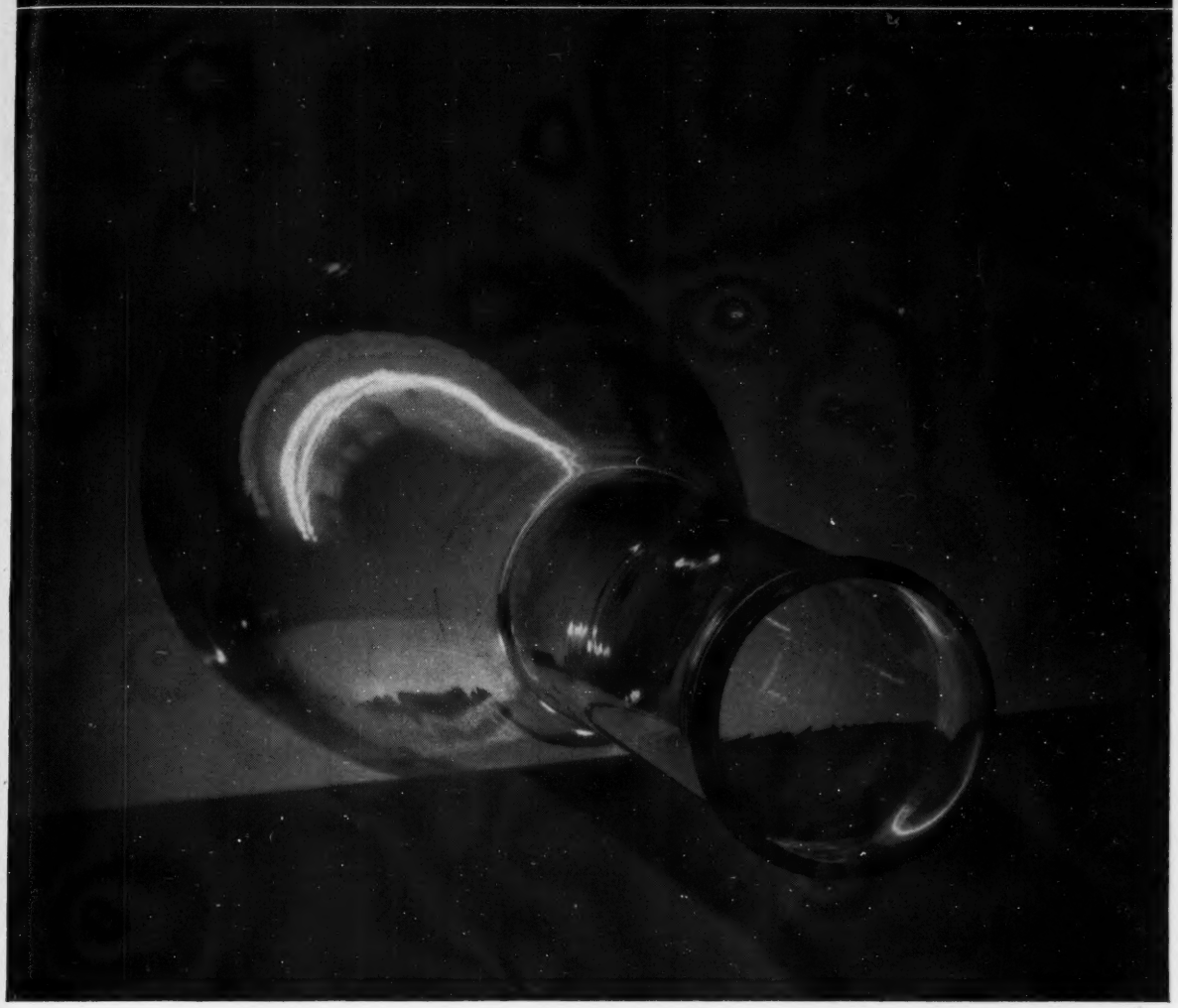
Prof. Ellenwood

(Continued from page 7)

outstanding fault in a teacher will then be brought to his attention in a definite manner. These opinions of the students will generally deserve, and probably receive, the sincere consideration of each member of our faculty.

Various methods of securing the candid opinion of a group of students may be devised. Possibly one of the simplest and most satisfactory methods would be what I shall designate as the "card system." This scheme would involve the use of printed cards containing a list of items that would be checked by a student to show both the good and bad points of each instructor. A student would not be expected to sign these cards but there should be a place provided for him to show by a check mark to which quarter of his class he belongs. These cards could be given to a class by each instructor at some period near the close of the term and they could be filled in by the students in a few minutes. The instructor should then collect the cards and study them carefully with the determination to try to overcome the defects in his teaching. These cards should be available for inspection by the Director and Dean at any time. Probably these administrative officers would rarely have occasion to examine these cards, but when such an occasion does arise the cards would be a source of useful information. The main purpose of the cards, however, will always be to show each instructor not only his chief shortcomings but, to some extent at least, the degree of success he has attained in his teaching.

How many lives is a glass bulb worth?



NO, it isn't a gun or a new-style bomb. It's just about all we can show you of a special glass radio bulb that is a part of our secret military apparatus.

At one stage in the war a high-ranking officer stated that a bulb of this type was so valuable and effective that he would risk the lives of five soldiers to keep it in operation. That's something to think about. And it's one reason why you find Corning men and women today striving to surpass quality standards that are already exacting.

This bulb is made of a special glass to very strict requirements. And so are most of the articles Corning is making for the Army and Navy and other services. They cover a wide range—from airplane wingtip lights to giant field marking beacon lenses. From laboratory ware for hospitals to optical glass for gunsights. From tough glass messware to thimblesize tubes for field radios.

And these are but a few of hundreds of items that Corning is making for the military services in addition to glassware for industries that supply chemicals and clothing, food, powder, rubber, and gasoline! In these fields and in many others Corning's deep knowledge of glass and glassmaking has made it possible to put this fairly plentiful material to work, not merely as a substitute, but as a new material capable of standing on its own feet and delivering better service in many instances than the one it replaces. Keep this in mind when the peacetime developments you will be working on, reach the blueprint stage—glass is amazingly versatile in the hands of people who know glass. And Corning has spent nearly a century getting acquainted with it. So, when you get to those blueprints, write us. Corning Glass Works, Corning, New York.

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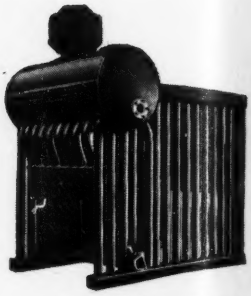
Seaworthy Since 1875



First B&W Marine Boiler

Completely assembled B&W Divided Furnace Boiler ready for installation in a destroyer.

Ever since the first B&W marine boiler went to sea nearly 70 years ago, the Babcock & Wilcox Company has continued to supply steam generating equipment—boilers and all auxiliary equipment—for all types and classes of naval vessels from battleships to tugs. During this long span of years, B&W has pioneered every important improvement and development found in modern marine boilers. To its long intimate pre-war knowledge of the requirements in this field, B&W has added much more valuable experience through serving the present war needs of both the Navy and Merchant Marine.

BABCOCK & WILCOX

The Babcock & Wilcox Company, 85 Liberty St., New York

AN-35

Dr. Carrier

(Continued from page 23)

tables at the turn of the century.

At the beginning of his Junior year, Willis Carrier was recuperating from typhoid fever and he could not start the year on schedule. He was out all of October, then all of November,—and his professors advised him not to even try to carry the Junior subjects with such a late start,—but Willis Carrier said he just had to, if he wanted to get a college education, for he was depending upon his scholarship to see him through—and the scholarship had a deadline date. So, despite the late start, he carried on, and continued with success in his scholastic work but sports were no longer a part of his activities. The extra studying required to make up for lost time did not permit participation in crew, running and boxing activities. In his Junior year, Willis H. Carrier and the classmates bought a laundry concession on the campus and combined the services of two laundries,—this was the beginning of the Students Laundry Agency that continues as a successful enterprise today.

In 1901, Willis H. Carrier received his M.E. degree in Electrical Engineering, after four years at Cornell. It was a period that welded an affection for his school which Dr. Carrier has demonstrated with his continued active interest in the affairs of Cornell and in his liberal financial contributions to the University. He is a member of the Cornell Alumni Council and is a frequent councillor for members of the instructing staff.

Upon graduation from college, Carrier, like most young people with a new diploma, started looking for a job. On his way to the Buffalo Forge Company in Buffalo, New York, he asked directions of a person near him on the trolley. The man replied, "I'm goin' there, so how about comin' along with me and I'll show you the way." The person was Mr. J. Irvine Lyle, and thus began a friendship between "Willis" and "Irvine" that lasted until the death of Mr. Lyle in 1942. Mr. Carrier "got the job" with the Buffalo Forge as research engineer, becoming chief engineer in 1906. In 1915, Willis H. Carrier, J. I. Lyle and five of their associates formed the Carrier Engineering Corporation. Later, two other companies merged with them to form the Carrier Corporation.

In 1902 Mr. Carrier married Edith Claire Seymour, who died in 1912. He then married Jennie Martin, a graduate of Cornell. She was active in community and social affairs, and a member of the Women's Cornell Club of Syracuse until the time of her death in 1939.

Known internationally as "The Father of Air Conditioning," Willis H. Carrier is recognized for his many contributions to the advancement of the engineering profession. References to "Who's Who", to the papers given to engineering and scientific societies, to current books telling of lives of engineers, and to various publications provide a profile of the professional history of Mr. Carrier. He was President of the American Society of Heating and Ventilating Engineers in 1931, President of the American Society of Refrigerating Engineers in 1927, was made an honorary member of the American Society of Mechanical

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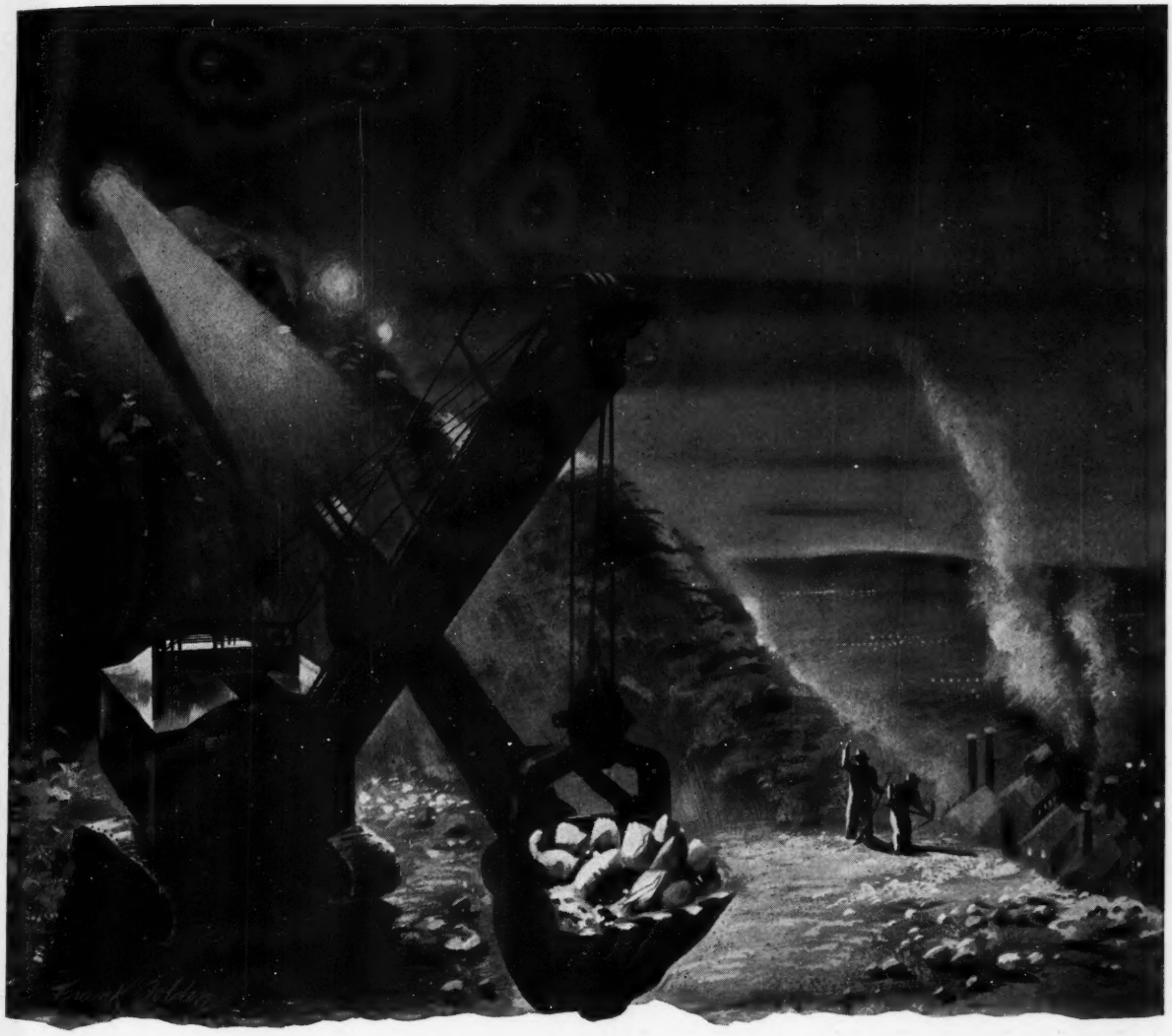

From ROCK *to* RUBBER

One of our country's large rubber plantations has its roots in limestone quarries. From this plentiful rock we produce carbide, then acetylene which is the basis of a widely used synthetic rubber.

Acetylene is one of the many chemicals available through the Airco family of companies for an infinite variety of uses, from cutting metal to preserving food. Today these chemicals are hastening victory—tomorrow a better world.

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Dr. Carrier

(Continued from page 50)

Engineers in 1940, representing the first two organizations at the World's Engineering Conference in 1929 and 1930. He was awarded the John Scott Medal for the invention of the processes and apparatus for air conditioning and refrigeration, the F. Paul Anderson gold medal for distingued scientific achievement in the same field. In 1934, he was awarded the medal of the American Society of Mechical Engineers, and the Brown Medal of the Franklin Institute, in 1941. In 1935, Lehigh University conferred on him the degree of Doctor of Engineering and, in 1942, Alfred University conferred on him the degree of Doctor of Science. He was elected to the Sigma Xi in 1914, and to Tau Beta Pi in 1938, and the Phi Kappa Phi in 1940. The National Association of Manufacturers honored Mr. Carrier bv selecting him as one of the 19 Modern Pioneers whose achievements have made our American industrial system the envy and example of the world.

Prof. Rhodes

(Continued from page 32)

carefully. Where there appeared to be general agreement that a specific instructor was unusually good or unusually poor, and general agreement as to the basis for the opinion, we did not hesitate to pass on to the instructor a summary of the opinions. In every instance, these criticisms were well received; in almost every case they resulted in improvement in the quality of teaching.

As part of the general program on the improvement of teaching in our school, we have held several evening meetings at which all members of our teaching staff, from assistants to professors, sat down with a member of the staff in Education to talk over teaching methods.

I believe that our procedure includes the essential elements of any workable plan for the improving of instruction: a method for getting considered opinions as to the effectiveness of teaching in the several courses, together with statements of the bases for such opinions; a critical analysis and review of these opinions, with means for passing on to the individual instructors the results of such analysis; and a discussion of methods for the remedying of the defects disclosed by the criticisms.

Cal Brown

(Continued from page 19)

recommends its study and adoption by the Student Council.

As if the above did not consume enough time, Cal manages to find time for several hobbies, including Stamp Collecting, photography, and playing bridge. He lives at Greentrees and is a faithful frequenter of the numerous parties and dances held around the campus.

Cal is working for the BCE degree which he expects in June. His plans for after that will be in the hands of the Armed Forces, but Cal is hoping to get a commission in the SeaBees. His post-war plans are indefinite now, but eventually Cal would like to enter the contracting business and build concrete and steel structures. His final ambition is to retire to a farm (with someone else doing the work) and there live a life of ease.

S P E C I A L

Slightly Used Drafting Supplies at Bargain Prices

Drawing Boards, 20x26 ..... 1.00
Tee Squares, 26" 1.25
Ames Lettering Instruments .... .50
Xylonite Protractors, 6" ..... .25
Triangular Scales ..... .35

Triangles, 30-60°

6" 15c
10" 35c
14" 60c
16" 75c
18" 1.00

Triangles, 45°

6" 20c
8" 25c
10" 35c
12" 50c
16" 75c

THE CORNELL CO-OP

Barnes Hall On The Campus

Manufacturer's Agents Wanted

in each of the following cities in New York State: Albion, Attica, Auburn, Batavia, Carthage, Corning, Dansville, Depew, Elmira, Geneva, Ithaca, Olean, Oneida, Oswega, Rochester, Rome, Schenectady, Tarrytown, Troy, Utica, Warwick, Watkins Glen, Wellsville. Must be civil engineer, or draftsman able to correctly estimate quantities from blue prints, to promote its use and specification among architects and general contractors and sell cement tile on a commission basis.

•

Morse Cement Tile Company
North East, Penna.

Two summers ago he was chasin' down cattle on a Texas ranch.

Now, in a truck he calls "Busy Lizzie," he hauls high-octane aviation gasoline round a jungle airfield. He's a key-man who knows every plane, pilot and crew-chief on the field.

All through the day and into the night he and his truck make their rounds, gassing up. And last thing, in the blackout of a jungle night, you can see the sparks his tail chain makes, dangling from the back of the truck, as it rattles across the steel-matted runway—still on the job.

Remember this cowboy and his truck of gasoline when you hear that American planes have destroyed yet another enemy target.

And remember him and the millions of his comrades *after* the war—men who have made *air travel, air cargo, air express* the business of their daily lives. And who will come home to make them safely, wonderfully and *surprisingly quickly* part of the daily life of their country.

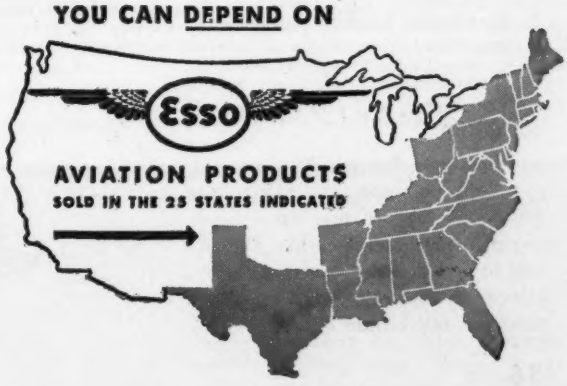
Cowboy in a Cab...headed for tomorrow

IT'S A GOOD BET *that the high-octane gasoline hauled by "Busy Lizzie" and her cowboy comes from the Esso refineries. Because every fourth combat plane in the Air Forces of the United States and Great Britain flies on gasoline from our refineries.*

With more than 40 years' practical experience in the manufacture of aviation petroleum products, together with a fund of new war-won knowledge and magnificent test-block and laboratory facilities, we will put extra power behind our promise that "You can depend on Esso Aviation Products."

COLONIAL BEACON OIL COMPANY

YOU CAN DEPEND ON



"Frequent water-drinking," says the specialist, "prevents you from becoming stiff in the joints."

"Yes, but some of the joints don't serve water."

* * *

Once on a dark and stormy night, a Knight was riding through the snow and bitter cold when he saw an inn ahead. He struggled up to the door, followed by his Saint Bernard, and asked the inn-keeper for a room. The landlord said that there were no rooms left, but the Knight said he just had to have a room. But there were still no rooms. So the Knight said he guessed he'd have to climb back on his Saint Bernard and ride to the next inn. The landlord said, "Did you ride up here on that dog?" "Of course," said the Knight. "Then I'll find you a room somehow," said the landlord, "I woldn't send a Knight out on a dog like this."

* * *

Doctor: "Why do you have TP76-520 tattooed on your back?"

Patient: "That's not tattooed, doctor. That's where my wife ran into me with the car when I was opening the garage door."

* * *

A genealogist was employed by Mrs. Newrich to work up an impressive family tree for her. The only ancestor on record turned out to be noteworthy by virtue of having been electrocuted for a crime.

After some thought, the genealogist finally reported to his employer that her ancestor had "occupied the chair of applied electricity at one of our better known public institutions."

* * *

"Conductor, will you help me off the train?"

"Certainly. But why?"

"Well, you see, I'm stout, and have to get off the train backwards. The porter thinks I'm trying to get on and he gives me a shove on again. I'm five stations past my desitnation now."

Prof: Now if there is anyone in the class who does not understand what I just explained, please stand up.

No one in the class stood.

Prof: Now don't be bashful; I just want to be sure you all understand.

Finally one boy rose.

Prof: Do I judge correctly by saying that you do not understand.

Student: No, Sir, I just didn't want to see you standing all alone.

* * *

"Are you a college man?"

"No, a horse stepped on my hat."

* * *

I'm all done with dames;
They cheat and they lie:
They prey upon males,
'Til the day we die.
They tease and torment us,
And drive us to sin . . .
Say look at the blonde that just came in.

* * *

A new musical production came to town. The billboards read: "50 beautiful girls—45 gorgeous costumes."

Three students and two policemen were trampled in the rush at the opening performance.

—El Burro

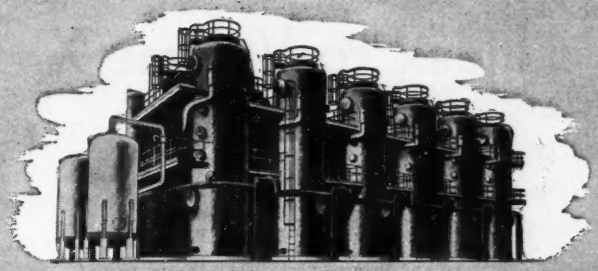
The editor of a newspaper was holding a space on the front page for a big story, and he sent a carrier pigeon to Washington to get the story and fly right back with it. Time passed and the pigeon didn't return. The editor waited all night, tearing his hair out and waiting for the pigeon. Finally in the morning the pigeon walked in the front door followed by a man. Said the editor, "And where have you been? I've been holding the front page all night."

Replied the pigeon, "You owe this man $38.50. It was raining when I reached Philadelphia, so I took a taxi the rest of the way."

* * *

There were two cockroaches sitting on a box of crackers. One sat in the middle and watched the other walk along one side of the top and then scoot along the other three sides. He kept this up many times —walking along one edge and speeding around the other three sides. Finally the first asked him why he acted thusly.

The second cockroach replied: 'Well, I walked along one side when all of a sudden I came to a sign that said, 'Tear along this line'."



UNION CARBIDE *AGAIN* REPORTS

on the production of

BUTADIENE

for the Government's Synthetic Rubber Program

ONE OF THE MOST IMPORTANT factors in the Government's rubber program is the production of GR-S type synthetic rubber.

The basic chemical in this rubber is Butadiene, which can be made from alcohol or hydrocarbon materials.

The Government's original plan provided that about one third of the required Butadiene would be made by CARBIDE AND CARBON CHEMICALS CORPORATION'S alcohol process.

In 1943, their first year of operation, however, the plants using this process produced over 75 per cent of all Butadiene made for GR-S type synthetic rubber.

In 1944, the second year, these plants produced about 64 per cent of all Butadiene necessary for military and essential civilian rubber. This was true despite the fact that good progress had been made in the production of Butadiene by other processes.

THE RECORD

The first tank-car load of Butadiene was shipped from the Government's Carbide-built, Carbide-operated plant at Institute, West Virginia a little over two years ago.

This was just five months after the famous Baruch Committee Report pointed out this nation's desperate need for rubber—and approved Carbide's butadiene alcohol process, originally selected by Rubber Reserve Company, as one of the solutions.

In its first year the Institute plant, with a rated capacity of 80,000 tons per year, produced enough Butadiene for more than 90,000 long tons of synthetic rubber.

Two more great plants using Carbide's alcohol process—and built from the blueprints of the Institute plant—are in full production. One of these, with an annual rated capacity of 80,000 tons of Butadiene is located at Kobuta, Pennsylvania and is operated for the Government by another important chemical company.

The second, with a rated capacity of 60,000 tons a year, is operated for the Government by Carbide at Louisville, Kentucky—making the total rated capacity of the two huge plants now operated by Carbide 140,000 tons a year.

In 1944, the production of Butadiene from the three plants using the alcohol process totaled 361,000 tons—representing operation at over 164 per cent of rated capacity. An even higher rate is expected in 1945.

* * * * *

Before Pearl Harbor, the United States was a "have not" nation with respect to rubber. Now, thanks to American research, engineering and production skill, our country can take its place as a dominant factor among the great rubber producing nations of the world.

▼

Business men, technicians, teachers, and others are invited to send for the book P5 "Butadiene and Styrene for Buna S Synthetic Rubber from Grain Alcohol," which explains what these plants do, and what their place is in the Government's rubber program.

SEPTEMBER 10, 1942

"Of all the critical and strategic materials, rubber is the one which presents the greatest threat to the safety of our nation, and to the Allied Cause.... We find the situation to be so dangerous that unless corrective measures are taken immediately the country will face both a military and a civilian collapse."

—Report of the Rubber Survey Committee (Baruch Committee).

AUGUST 31, 1944

"Undoubtedly the outstanding achievement of your company has been the development of your process for the production of Butadiene from alcohol. With a rather meager background of experimental work, your engineers were able to design and construct commercial units for the production of Butadiene. In an exceedingly short time, the operation of this equipment at capacities up to 200 per cent of rating has been largely responsible for our present safe situation with respect to rubber supplies..."

—Letter from Rubber Director Bradley Dewey to CARBIDE AND CARBON CHEMICALS CORPORATION

The material herein has been reviewed and passed by the Rubber Reserve Company, the Defense Plant Corporation, and the War Department.

BUY UNITED STATES WAR BONDS AND STAMPS

UNION CARBIDE AND CARBON CORPORATION

30 East 42nd Street UCC New York 17, N. Y.

Principal Units in the United States and their Products

ALLOYS AND METALS—Electro Metallurgical Company, Haynes Stellite Company, Kemet Laboratories Company, Inc., United States Vanadium Corporation
CHEMICALS—Carbide and Carbon Chemicals Corporation **PLASTICS**—Bakelite Corporation **ELECTRODES, CARBONS & BATTERIES**—National Carbon Company, Inc.
INDUSTRIAL GASES AND CARBIDE—The Linde Air Products Company, The Oxweld Railroad Service Company, The Prest-O-Lite Company, Inc.

Index to Volume X

ARTICLES

	Number	Page
Aluminum—Structural Metal of the Future Herbert S. Meltzer, CE '47	8	12
Army Engineers, Thoughts and Deeds Colonel Carlton S. Proctor	2	9
Carbon Dioxide Fire Extinguishers Ronald M. Taylor	3	9
Ceramic Industry Today, The Roderick W. Pearson, ChE '47	6	12
Chemical Engineering in the Future Professor F. H. Rhodes	3	7
Communications Richard E. Goll, V-12	1	15
Constructing the Iraq Pipeline Herbert S. Austin	6	9
Cornell's Post War Engineering Plans Dean S. C. Hollister	1	64
Developments in Communications—1 Walter R. Jones, E.E. '25	1	17
Developments in Communications—2 Prof. C. A. Priest	1	19
Engineering at Cornell 1. Material Processing Richard E. Goll, V-12	2	14
Engineering at Cornell 2. Electrical Engineering Laboratories Lawrence W. Simmons, V-12	3	18
Engineering at Cornell 3. Department of Physics L. R. Anderson, V-12	4	14
Engineering at Cornell 4. Chemical Engineering Laboratories Roderick W. Pearson, ChE '47	5	16
Engineering at Cornell 5. An Experiment in Instruction Prof. Louis L. Otto	6	14
Engineering at Cornell 6. Civil Engineering Laboratories Adam Paul Friedrich, CE '46	7	14
Engineering at Cornell 7. Materials Testing Laboratory Anthony S. Rugare, ME '47	8	16
Engineer In Russia, An Prof. George Winter, Ph.D. '40	8	8
Foods and Farming Marguerite E. Haven, ME '45	1	37
Future of Frozen Foods, The Dr. Donald K. Tressler, Ph.D. '18	1	39
Hardenability of Steel Anthony S. Rugare, ME '47	3	14
Housing Roderick W. Pearson, ChE '47	1	27
Hundred Helicopters, A Charles C. Hansen, ME '46, V-12	7	12
Instructional Material for Training Programs Professor Lynn A. Emerson	6	7
Inter-American Industrial Standardization Ben-Ami Lipetz, ME '47	3	12
Legibility of Symbols as an Engineering Problem, The Dr. Curt Berger	4	7
Machine that Took Lithography out of the Stone Age, The Alan R. Hirsch, AEME '48	4	12
Man and Weather Morris S. Helitzer, ME '46	4	10
Materials Ben-Ami Lipetz, ME '47	1	21
Materials Tomorrow Prof. J. O. Jeffrey	1	24
Mighty Mites of Industry L. R. Anderson, V-12	2	12
New Material and Construction Methods Bernard A. Savage, M.E. '25	1	33
Note on Post War Architecture, A Frederick L. Ackermann, Arch. '01	1	29
On The Air Billie P. Carter, ChE '48	5	13
Physics Applied Anthony R. Morrow	3	32
Physical Methods in Production Control Dr. Henri S. Sack	5	8
Post War Expressways Dean Gilmore D. Clarke, B.S. '13	1	12
Post War Wage Trends Frank D. Newberry, M.E. '01	1	7
Powder Metallurgy Donald S. Ironside, EE '46	8	14
Quarter Century of Engineering Retrospect, A Prof. L. D. Doty	7	10
Radar History Jacques L. Zakin, ChE '47	5	11
Some Useful Laboratory Gadgets Robert H. Olson, ChE '46	8	14
Transportation Malcolm E. Steinberg, CE '47	1	9
U.S.S. Dolphin in Search of a Storm, The Dr. W. F. Durand	2	7

AUTHORS

Ackermann, Frederick L., Arch. '01	1	29
Anderson, L. R., ME, V-12	2,4	12,14
Austin, Herbert S.	6	9
Berger, Dr. Curt	4	7
Carter, Billie P., ChE '48	5	13
Clarke, Dean Gilmore D., B.S. '13	1	12
Doty, Prof. L. D.	7	10
Durand, Dr. W. F.	2	7
Emerson, Prof. Lynn A.	6	7
Friedrich, Adam Paul, CE '46	7	14
Goll, Richard E., V-12	1,2	15,14
Hansen, Charles C., ME '46. V-12	7	12
Haven, Marguerite E.. ME '45	1	37
Helitzer, Morrie S., ME '46	4	10
Hirsch, Alan R., AEME '48	4	12
Hollister, Dean S. C.	1	64
Ironside, Donald S., EE '46	8	14
Jeffrey, Prof. J. O.	1	24
Jones, Walter R., E.E. '25	1	17
Lipetz, Ben-Ami, ME '47	1,3	21,12
Meltzer, Herbert S.. CE '47	8	12
Morrow, Anthony R.	3	18
Newbury, Frank D., M.E. '01	7	7
Olson, Robert H., ChE '46	8	14
Otto, Prof. Louis L.	6	14
Pearson, Roderick W., ChE '47	1,5,6,	27.16,12
Priest, Prof. C. A.	1	19
Proctor, Colonel Carlton A.	2	9
Rhodes, Prof. F. H.	3	7
Rugare, Anthony S., ME '47	3,8	14,16
Sack, Dr. Henri S.	5	8
Savage, Bernard A., M.E. '25	1	33
Simmons, Lawrence W.. V-12	3	18
Steinberg, Malcolm E., CE '47	1	9
Taylor, Ronald M.	3	9
Tressler, Dr. Donald K.. Ph.D. '18	1	39
Winter, Prof. George, Ph.D. '40	8	8
Zakin, Jacques L., ChE '47	5	11

PERSONALITIES

Accorsi, Frank, ME	4	16
Allen, Roland P., CE	3	17
Bailey, George H., ME '46	7	16
Brown, Calvin G., CE '46	8	18
Carrier, Willis H.	8	23
Christtensen, Paul, AE '46	7	16
Cranch, Edmund T., ME	3	16
Day, David, CE	4	17
Edison, James E., ChE '46	5	18
Fraser, John P., ChE	3	16
Gieseler, Henry, ME '46	8	18
Hansen, Charles C., ME	6	17
Haven, Marguerite E., ME '45	6	16
Heartfield, Seth Jr., CE '45	6	16
Hecht, Malcolm, ChE '46	5	18
Kornhauser, Edward, EE	3	17
Lipetz, Ben-Ami, ME '47	6	17
Littlewood, William, ME '20	7	21
Moore, Harry C., Jr., ME '46	8	18
Pierce, Donald R., Arch '46	7	17
Rasch, John H., ME '46	5	19
Richardson, William, ME	4	17
Riehl, Bud, ME '46	7	17
Ripley, Joseph Pierce, ME '12	5	15
Sinclair, Robert, EE	4	16
Smith, Gordon S., EE '46	8	18
Tulley, John, CE '46	5	19

In a field hospital, a SURGEON uses a new x-ray machine that marks the exact location of the bullet, speeds life-saving behind the battle line.

... the name on the X-RAY MACHINE is Westinghouse.

In a laboratory an ENGINEER uses the instantaneous power of 75,000 thunderbolts to test giant circuit breakers that protect America's power systems.

... the name on the CIRCUIT BREAKER is Westinghouse.

In his tent a SOLDIER uses a bug bomb to destroy insect life – safeguarding health and increasing comfort in tropical jungles.

... the name on the BUG BOMB is Westinghouse.

In a war plant a WORKER uses an electromagnetic device to detect flaws in heat-treated bearing races – keeping our combat vehicles rolling on to victory.

... the name on the ELECTROMAGNETIC DEVICE is Westinghouse.

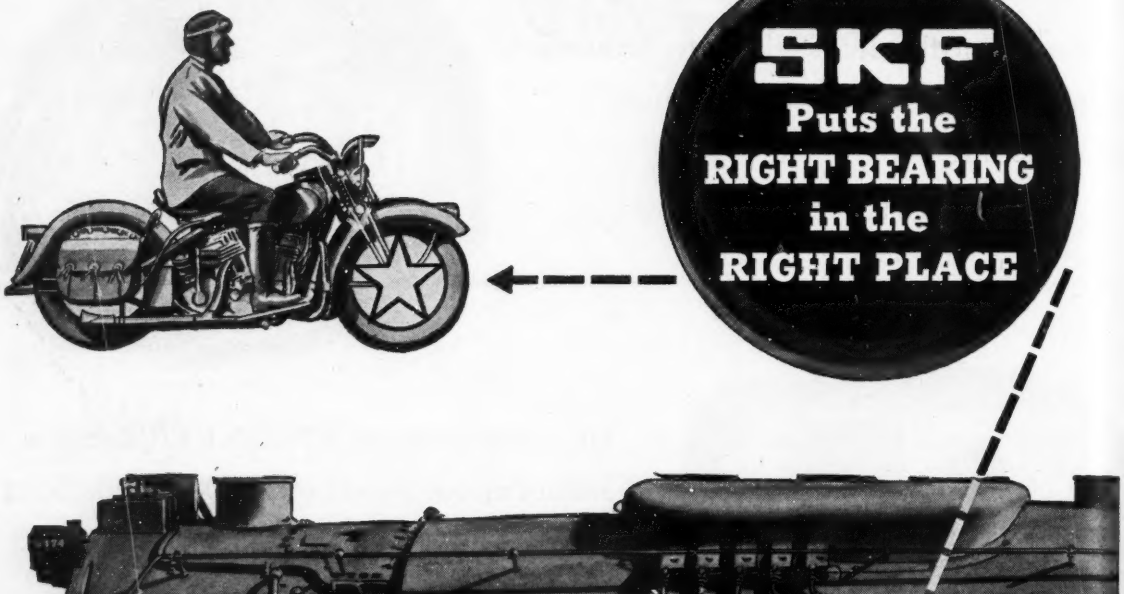
Westinghouse

PLANTS IN 25 CITIES OFFICES EVERYWHERE

TODAY—Westinghouse products are serving in every battle, on every front, in the war against aggression.

TOMORROW—New processes and new materials...created under the stress of war... will mean better and longer-lasting Westinghouse products for a world at peace.

Tune in: JOHN CHARLES THOMAS—Sunday 2:30 pm, EWT, NBC. TED MALONE—Mon. Tues. Wed. Evening, Blue Network



SKF Puts the RIGHT BEARING in the RIGHT PLACE

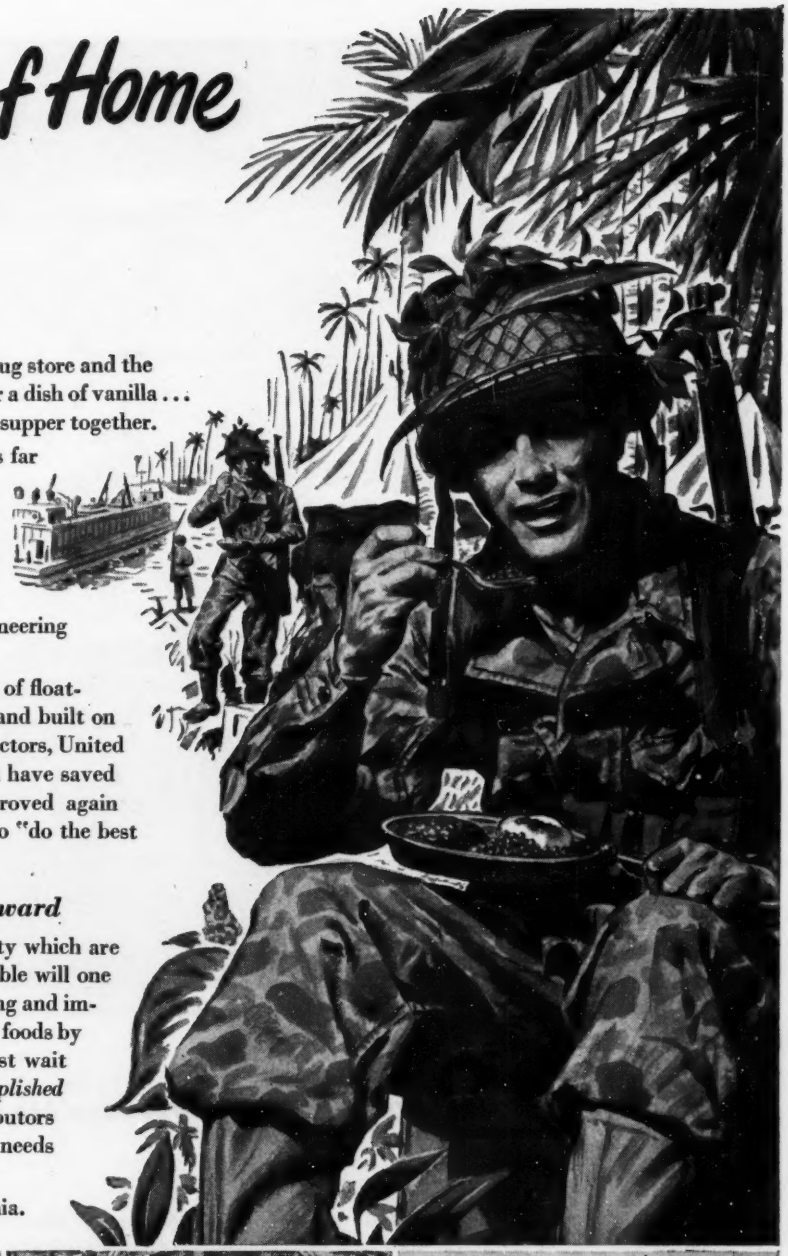
For every application where a bearing is needed . . . whether for the vital rotating parts of a powerful modern locomotive or the comparatively simple requirements of a motorcycle . . . there is *one* type and size of bearing that will do the job *right*. Anything else is a substitution—not quite so efficient.

That's why SKF makes a *complete* line of both ball and roller bearings. True, in wartime, you have not always been able to obtain the SKF bearings you needed. That was because our armed forces have demanded so much of our production that even a six-times increase in capacity couldn't meet all the heavy military and civilian requirements.

Some day — fairly soon, we hope — SKF and its distributors will again be able to offer you prompt service on a complete line. SKF makes practically all types of anti-friction bearings. Therefore, when SKF recommends a particular type of bearing, you may be sure that its recommendations are unbiased—*the right bearing in the right place.*

SKF INDUSTRIES, INC., PHILA., PA. 6003

A Taste of Home



Perhaps he is thinking of the corner drug store and the old gang talking football prospects over a dish of vanilla . . . or a farmhouse kitchen and a family at supper together.

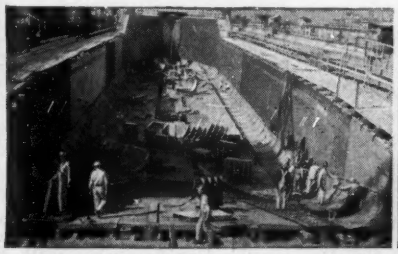
But some of these things are not as far from the lads in the remote South Pacific as you may think. Wherever possible, fresh meat, vegetables—yes, even ice cream from home are brought to them through the miracle of refrigeration and a miracle of American engineering ingenuity!

Concrete "Reefer" barges—285 feet of floating refrigerator—planned, engineered and built on the beaches by Concrete Ship Constructors, United Fruit Company and York Corporation have saved six months of ship building time—proved again that, in a crisis, America knows how to "do the best with what she has."

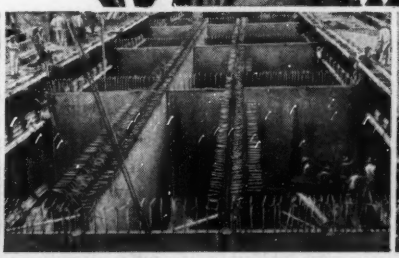
Refrigeration Looks Forward

The experience and engineering ability which are now making these achievements possible will one day return to the problem of broadening and improving the distribution of refrigerated foods by land, sea and air. But these things must wait for Victory . . . Only when it is an *accomplished fact* can York workers and York distributors turn to the job of satisfying the pent-up needs of a peacetime world.

York Corporation, York, Pennsylvania.



MIRACLE OF SPEED! Just six days after keel laying this concrete "reefer" was launched. The photo above was taken a little more than an hour after construction started.



ANSWER TO THE SHIPPING PROBLEM. With shipways crowded to capacity, Concrete Ship Constructors, United Fruit Co. and York Corporation engineered and built barges on the beaches,

FIRST FLOATING REFRIGERATOR puts to sea . . . the *USS Hydrogen* heads for the South Pacific.

york refrigeration air conditioning

YORK REFRIGERATION AND AIR CONDITIONING

HEADQUARTERS FOR MECHANICAL COOLING SINCE 1885

RCA Laboratories model with an 18 by 24-inch screen showing how Bob Hope may appear on future home television.

New Projection Television - Bob Hope's face "big as life"

Can you picture Bob Hope on television . . . seeing his face *big as life*—right in your own living room?

Well, you will—for now, thanks to RCA research, all limitations on the size of home television screens have been removed.

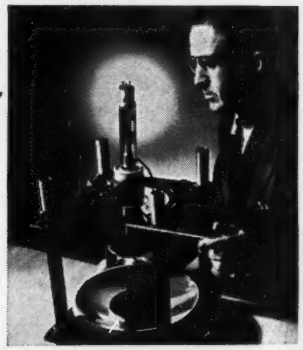
RCA Projectior Television sets can have 18 by 24-inch pictures, or for that matter, pictures as large as the screen in a "movie" theater!

When you tune in an NBC television broadcast you'll almost think the actors are in the same room with you—and trust NBC, America's No. 1 network in sound broadcasting, to bring you the best in television entertainment.

This revolutionary improvement was achieved in RCA Laboratories by development of an entirely new reflector and lens, shown in phantom above. This lens, of inexpensive plastic, is 8 times as efficient for the purpose as the finest optical lens.

When you buy an RCA radio, phonograph or television receiver—or any other RCA product—you receive the benefit of the latest research development of RCA Laboratories. It is this *plus value* which is your assurance of lasting satisfaction.

The widespread public recognition of this plus value has given to RCA world leadership in the radio, phonograph, television and electronic art.



Dr. D. W. Epstein with a projection television tube, reflector and lens unit. Here the image on the end of the tube hits the reflector, is corrected by the lens, projected to the screen, then enlarged . . . making possible larger and clearer television than ever before.

RADIO CORPORATION of AMERICA

PIONEERS IN PROGRESS

RCA

FOR *Greater Success* IN ENGINEERING

Learn to know your Bearings

A thorough knowledge of Timken Bearing design and application will be one of your best assets when you graduate to enter the professional engineering field. Begin to acquire it now. Here are the three most important features exemplified in the design of the Timken Bearing.

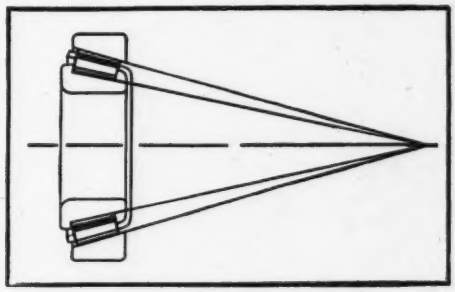


FIGURE 1

1. TRUE ROLLING MOTION

This basic necessity is assured by making all lines coincident with the tapered surfaces of the rollers, cup and cone, meet at a common apex on the axis of the bearing, Figure 1. True rolling motion always has been incorporated in the Timken Bearing.

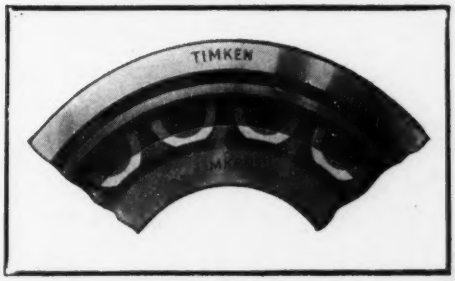


FIGURE 2

2. POSITIVE ROLLER ALIGNMENT

During the development of the Timken Bearing, as speed, load and accuracy requirements increased, various methods were used to stabilize the rollers and prevent them skewing in the raceways. The solution was found in establishing wide-area contact between the large ends of the rollers and the undercut rib of the cone, thus assuring constant and accurate roller alignment around the periphery of the raceways. The light areas on the ends of the rollers in Figure 2, show contact of rollers with undercut rib of cone.

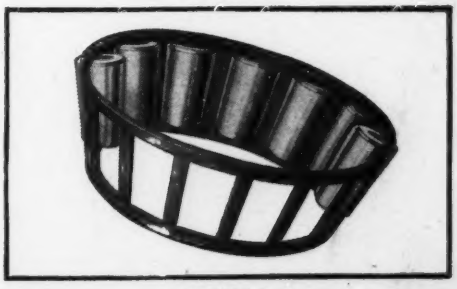


FIGURE 3

3. MULTIPLE PERFORATED CAGE

All the openings in the Timken Bearing cage, Figure 3, are stamped out in one operation by means of multiple perforating dies made to extremely close precision tolerances. This assures exact center-to-center spacing of the rollers around the periphery of the raceways, so that every roller takes its full share of the load when the bearing is in operation.

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

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GE Campus News

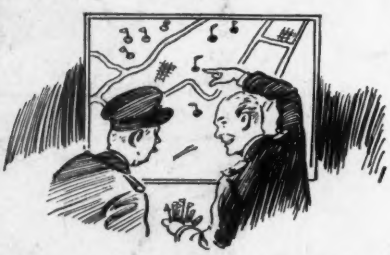
RESEARCH AND ENGINEERING KEEP GENERAL ELECTRIC YEARS AHEAD

HOSPITAL ON WHEELS

SOME PEOPLE—perhaps when they're very young—have a touch of tuberculosis. It may be just a spot on their lungs, which hardens and never causes any trouble. On the other hand, thirteen people out of a thousand, when examined by X ray, show evidence of reinfection tuberculosis. This does cause trouble unless it's treated at once.

G-E photo-roentgen units make it possible for public health and welfare organizations to reach and examine, not only thousands of persons in large cities, but in rural areas and thinly settled sections as well.

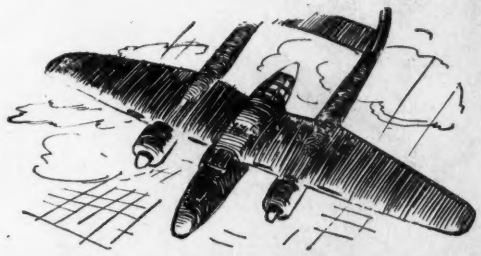
Forty-five to sixty chest X rays an hour is the record of mobile units designed and built by the G-E X-Ray Corporation. As each person takes his turn in the bus-like vehicle, a small fast-lens camera transfers his chest image from the standard size fluorescent screen onto a supersensitive 4 x 5 inch X-ray film.



MAGNETIC MAP MARKERS

LOCATING an enemy position or tracing the course of our own convoy is a war job of the alnico magnet. Both Army and Navy use G-E sintered alnico as magnetic map markers—with its aid keep abreast of vital information.

Alnico is an alloy—of aluminum, nickel, cobalt, and iron—with greater magnetic power than any other known material. To make sintered magnets G.E. begins by pressing powders of all these metals. After heating and wet grinding, one surge of current makes alnico a permanent magnet. And with a piece of steel behind the wall map, the markers can move around but won't fall off.



DEATH FROM A P-61

SOMEWHERE in the European theater of operations there is a squadron group called the Green Bats, whose Northrop P-61 Black Widow planes carry as their insigne a green bat against a yellow moon.

These Widows fight by night—with G-E remote-control gunfire. Once they let loose, the four electrically-operated .50 calibre guns can swing a deadly barrage on their target. Each plane has two sighting stations. A gunner at either of them—or the pilot himself—can take a turn at building up the high score of enemy planes downed. In the two months following D-Day it totaled 400 for the Bats—and groups like them.

General Electric Company, Schenectady 5, N. Y.

Hear the G-E radio programs: "The G-E All-girl Orchestra," 10:00 p.m. EWT, NBC—"The World Today" news, 6:45 p.m. EWT, CBS—"The G-E House Party," 4:00 p.m. EWT, CBS.

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